A Study of the Relationship of Various Grades of Fresh and Canned Vegetables

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II—CANNED TOMATO JUICE

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Ohio Agricultural Experiment Station
and
Norman C. Healy
Agricultural Marketing Service
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OHIO AGRICULTURAL EXPERIMENT STATION

WOOSTER, OHIO

Department of Horticulture
Mimeograph Series No. 55

January
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OF

FRESH AND CANNED VEGETABLES

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Contents

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This is part II of a series of publications on a study of the relationship of various grades of fresh and canned vegetables.
Part I of this series dealt with Canned Tomatoes (Published April 1953)
Part III of this series dealt with Canned Tomato Pulp (Puree) (Published July 1953).

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A STUDY OF THE RELATIONSHIP OF VARIOUS GRADES OF FRESH AND CANNED VEGETABLES[1]

II. CANNED TOMATO JUICE

by

W. A. Gould, Rees B. Davis, James O. Mavis and Fred Krantz, Jr.[2]
Ohio Agricultural Experimental Station
and
Norman C. Healy
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INTRODUCTION

This project was initiated in 1949 in Ohio as a cooperative study with the U. S. Department of Agriculture and the Ohio Agricultural Experiment Station in accordance with provisions of the Agricultural Marketing Act of 1946. The U. S. Standards for Grades of Canning Tomatoes and the U. S. Standards for Grades of Tomatoes for Manufacture of Strained Tomato Products have been widely used by both canners and growers since their issuance. Likewise, the U. S. Standards for Grades of Canned Tomatoes, Tomato Juice, and Tomato Puree have been used extensively by canners and distributors of processed foods. To date a limited amount of research has been devoted to the relationship of the yield, in cases per ton, and the grade of canned tomatoes and tomato products which may be packed from given quantities and grades of the fresh product. Growers and processors, as well as officials of the cooperating agencies, have believed for some time that accurate data should be obtained through research to show the relationship between the grades of fresh and processed tomatoes and tomato products.

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1. This work was conducted as a part of a cooperative project between the New York (Geneva), Purdue and Ohio Agricultural Experiment Stations and U.S.D.A. under the Agricultural Marketing Act of 1946.
2. Formerly Research Assistant, Ohio Agricultural Experiment Station; present address - Campbell Soup Company, Camden, New Jersey.

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This research project on tomatoes, therefore, has been developed with the following objectives:

(1) Determine quality of tomato juice from various qualities of raw tomatoes;

(2) Study the most advantageous use which might be made of various grades of raw tomatoes for manufacture of specific grades of canned tomato juice;

(3) Ascertain possible improvements in the U. S. Standards for Tomatoes for Manufacture of Strained Tomato Products and U. S. Standards for Grades of Tomato Juice in order to increase the usefulness of such grades.

This report is limited to the study of the relationship of the grade of tomato juice which may be manufactured from various grades of fresh tomatoes.

EXPERIMENTAL METHODS

Varieties

Research work was started during the 1949 tomato canning season and continued through the 1952 season. In 1949, Rutgers and Stokesdale varieties were grown at the Northwest Test Farm of the Ohio Agricultural Experimental Station at Holgate, Ohio. In 1950, two varieties, Rutgers and Stokesdale, and in 1951, three varieties, Rutgers, Stokesdale and Long Red were grown on the Horticultural Farm at The Ohio State University, Columbus, Ohio. In 1952 only the Rutgers variety was grown on the Horticultural Farm at The Ohio State University, Columbus, Ohio.

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Growing Practices

During all four years the tomatoes were grown in accordance with acceptable commercial practice for production of canning tomatoes in Ohio. In 1949, the tomatoes were grown on Paulding clay soil with 200 lbs. of cyanamid and 800 lbs. of 0-12-12 fertilizer plowed down. In 1950, 1951, and 1952, the tomatoes were grown on a silt loam soil, with green manuring crop (rye) plowed down prior to planting. In 1950, the tomato field received approximately twenty tons of manure per acre. In 1950, 1951, and 1952, 1000 lbs. of 5-10-10 fertilizer was disked in at the time of fitting the soil approximately two weeks before planting date. In all four years the tomato plants were started in flats in the greenhouse, conditioned in cold frames and transplanted in the field as soon as danger of the last killing frost had passed. No starter solution was used at the time of transplanting, but in 1950, 1951, and 1952, the plants were irrigated immediately after transplanting.

At seven to ten day intervals throughout the growing season, up to harvest time, the plants were sprayed with fixed copper alternating with Ziram (Zerlate) to control early blight, late blight, anthracnose, and dusted following University recommendations to control flea beetles and aphids.

Harvesting was started when the fruits were mature enough to comply with the quality (Table A) as desired for processing in the pilot plant (Table B). The first picking of both varieties was started on September 2 in 1949 and ended on September 30; in 1950, picking was started on Stokesdale August 28 and finished September 16;

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picking of Rutgers started August 28 and finished September 26. In 1951, picking was started on August 9 for Stokesdale and finished on August 29; picking of Long Red started on August 9 and finished September 13; picking of Rutgers started on August 13 and finished September 18. In 1952, picking of Rutgers was started on August 8 and finished on September 25. Harvesting was continued at weekly intervals until the tomatoes became too small in size to be handled by the processing machinery or until the plants and fruits were killed by frost.

Quantity Packed

During the 1949 canning season, 48 lots of tomato juice were processed. In 1950, 101 lots were processed; in 1951, 200 lots, and in 1952, 64 lots of tomato juice were processed making a total of 413 lots of tomato juice for the four years.

Raw Products Grading

Prior to processing, the fresh tomatoes were graded by an official inspector (a different inspector was used each year) of the Federal-State Fruit and Vegetable Inspection Service. Each tomato was graded and segregated individually according to the factors of color and defects as outlined in the U. S. Standards for Manufacture of Strained Tomato Products. (Table A).

A grading table shaded from direct sunlight was provided outside the tomato processing pilot plant at The Ohio State University. The official inspector handled each fruit individually and segregated the tomatoes into four grades as follows:

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(1) U. S. No. 1;

(2) U. S. No. 2 for color (U. S. No. 1 for defects);

(3) U. S. No. 2 for defects (U. S. No. 1 for color);

(4) Culls.

For certain lots the inspector further distinguished between U. S. No. 1's for color by separating them into lots designated as high U. S. No. 1's for color and low U. S. No. 1's for color. Likewise, the U. S. No. 2's for color were separated into high U. S. No. 2's (approximately 80% good red color up to 90% good red color) and low U. S. No. 2's (approximately 66 2/3% good red color up to 80% good red color) for color.

Tomatoes graded and sorted by the inspector were recombined in lots of definite percentages (Table B) and processed usually within two hours after grading.

Processing Methods

A flow diagram of the canned tomato, tomato juice and tomato pulp operations is shown in Figure 1. The specific steps in the pilot plant processing of tomato juice are discussed below.

In 1949 and 1950, 100 pound lots were prepared according to the percentage of U. S. No. 1's, U. S. No. 2's for color, U. S. No. 2's for defects, and culls for processing tomato juice (Table B). In 1951 and 1952, 100 pound lots were prepared as in 1949 and 1950; and, in addition, 500 and 1000 pound lots were also prepared and processed in the pilot plant, primarily for yield studies.

The lots of tomatoes for juice manufacture were placed in an air-agitated washer for three to five minutes, then conveyed on a roller type washer which elevated the tomatoes up under a 120-130

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TABLE A. U. S. Standards for Tomatoes for Manufacture of Strained Tomato Products (March 1, 1933)[1]

Factors	U. S. No. 1	U. S. No. 2
Color	"well colored" 90% of flesh has good red color.	"fairly well colored" 66 2/3% of flesh has good red color.
Firmness	Fairly firm (means not water soaked, might be soft, shriveled, or puffy; provided it is not tough or rubbery).	No requirement; tomatoes can only be scored as culls from the standpoint of losing more than 20% in the washing process, provided they are not shriveled to the extent that they have become tough and rubbery.
Stems	Not permitted (except when the canner wishes to permit stems. In such cases it can be handled by a statement preceding No. 1 Grade. Thus: "Except for stems U. S. No. 1")	Permitted
Decay or Mold	Molds or very light decay permitted provided it can be washed out in the ordinary process of washing without hand trimming.	Permitted, provided the tomato is not sour and it can be removed in the ordinary process of trimming without a loss of more than 20% by weight of the tomato.
Sunburn, Sunscald, Growth Cracks, Catfaces, Freezing Injury	*Free from damage.	**Free from serious damage.
Worms and Worm Injury	Worms or worm injury that has penetrated beneath the outer wall of the tomato not permitted.	Same as U. S. No. 1
Shape	There are no shape requirements.	No requirement
Size	There are no size requirements.	No requirement

* "Damage" means any injury, defect, or their combination which cannot be removed in the ordinary process of trimming and peeling without a loss of more than 10% (by weight) of the tomato in excess of that which would occur if the tomato were perfect.

** "Serious damage" means any injury, defect or their combination which cannot be removed in the ordinary process of trimming and peeling without a loss of more than 20% (by weight) of the tomato in excess of that which would occur if the tomato were perfect.

Note - Cull tomatoes are tomatoes that fail to meet the requirements of either U. S. No. 1 or U. S. No. 2 tomatoes.

1. Issued by the U. S. Dept. of Agr., Agricultural Marketing Service.

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pound high pressure water spray. Each tomato was subjected to the equivalent of approximately two revolutions while being washed under the high pressure spray.

Tomato juice was processed in 1949 and 1950 by the "cold break" extraction method. In 1951 and 1952, both "hot break" and "cold break" extraction methods were used in the processing of tomato juice.

For the "cold break" tomato juice, the fresh, whole tomatoes were conveyed directly from the washer to a Langsenkamp Model B Extractor with a screen of .023 inch openings where the tomato juice was extracted.

In 1951 and 1952, tomato juice was extracted as described above (one extract) and, in addition, was extracted as described above and the residue from the first extraction was again extracted in the Langsenkamp Model B Extractor (2nd extract). The juice thus obtained from the two extractions was combined and further processed as described below.

For the "hot break" juice, the fresh, whole tomatoes were conveyed to a Fitzpatrick Model D Comminuting Machine using a No. 6 (3/4 inch openings) screen. The Fitzpatrick Comminuting Machine was used as a chopper rather than as a hammer-mill. The chopped tomatoes were pumped from a receiving tank at the comminuting machine through a Specialty Brass Company Tube Preheater where the chopped tomatoes were heated to a temperature of approximately 180°F. The heated and chopped tomatoes were then pumped to the Langsenkamp Model B Extractor where the juice was extracted.

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TABLE B. Composition of Lots of Raw Tomatoes for Processing of Canned Tomato Juice.

TOMATO JUICE

Composition

Lot No.	Percent No. 1's		Percent No. 2's		Percent Culls
	Color	Defects	Color	Defects	
1	100	-	-	-	-
2	-	-	100 High #2's	-	-
3	75	-	25	-	-
7	50	-	50	-	-
8	-	-	100	-	-
10	-	-	-	100	-
11	-	-	-	-	100
13	75	-	-	25	-
14	50	-	-	50	-
15	25	-	75	-	-
16	25	-	-	75	-
20	Field Run				
21	-	-	100 Low #2's	-	-
22	100 High #1's	-	-	-	-
23	100 Low #1's	-	-	-	-

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In 1951, following the "hot break" and "cold break" methods of extraction, three processes were used to preserve the juice as follows:

(1) The extracted juice was pumped by means of a Cherry-Burrell Viscolizer, which had the "breaker-ring" altered to prevent any homogenization of the juice, to a Walker-Wallace Paraflow Plate Heat Exchanger (Model HT with 4 pair of stainless steel plates) where the juice was heated to 240°F. and held for 2 1/2 minutes and cooled to approximately 205°F. The juice was then filled into No. 2 plain tin cans, 60 grains of sodium chloride was added, the cans were then sealed, inverted and held 2 1/2 to 3 minutes prior to cooling to approximately 100°F. All the juice in 1949, 1950, 1952 and approximately two-thirds of the pack in 1951 was pasteurized using the above process. This process will be referred to throughout this paper as the "hot break" or "cold break" plate-pasteurized process.

(2) The extracted juice was pumped by means of a Manton-Gaulin Pump to a Mallory Tube Pasteurizer where the juice was heated to 265°F. and cooled immediately to approximately 200°F. The juice was then filled into No. 2 plain tin cans, 60 grains of sodium chloride was added, the cans were sealed, inverted, and held 2 1/2 to 3 minutes prior to cooling to approximately 100°F. In 1951, several lots were processed in this manner which will be referred to as the "hot break" or "cold

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break" tube-pasteurized process.

(3) The extracted juice was preheated with a Specialty Brass Company Tube Preheater to 180°F., filled directly into No. 2 plain tin cans, 60 grains of sodium chloride was added, the cans were sealed, inverted, and placed in a retort crate (150 No. 2 capacity) and processed at 1 to 2 pounds steam pressure (214 to 216°F.) for 30 minutes. Process time and temperature was automatically controlled and recorded. After processing, the tomato juice was cooled in the retort with cold water to approximately 100°F. by continuously running water in from the bottom to the top of the retort. Similar methods of heat processing are used in some commercial plants in Ohio at the present time and this method of processing was incorporated in the 1951 study to compare this process ("Conventional" process) to the above processes.

In 1951, the extracted juice from the 500 and 1000 pound lots was divided in certain instances with part of the juice processed by the plate-pasteurized process and/or part by the tube-pasteurized process and/or part by the conventional process as described above. Thus, it was possible to study the effect of processing methods on the grade relationship of tomato juice manufactured from identical grades of raw stock and with identical extraction methods.

The finished product was then held at room temperature until graded. During all four years the lots were graded after approximately 2 months storage, 6 months storage, and 10 months storage,

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except in 1952. In 1952 the lots were graded only after 1 and 5 months storage.

Finished Product Grading

The tomato juice processed from lots of varying compositions as outlined in Table B were graded in accordance with the U. S. Standards for Grades of Tomato Juice (see Table C) by one official inspector in 1949 and two official inspectors in 1950, 1951 and 1952 from the Processed Products Standardization and Inspection Branch, Fruit and Vegetable Division, Agricultural Marketing Service of the U. S. Dept. of Agriculture. The canned tomato juice was graded according to the grade factors presented in the U. S. Standards for Grades of Tomato Juice (Canned or Bottled) as given in Table C.

TABLE C. U. S. Standards for Grades of Tomato Juice (Canned or Bottled)

(August 29, 1938)

Factors	Score Points		
	U.S. Grade A	U.S. Grade C	U.S. Grade D
Color	26-30	23-25*	0-22*
Consistency	13-15	10-12*	0- 9*
Absence of Defects	13-15	10-12*	0- 9*
Flavor	33-40	27-32*	0-26*
Total Score	85-100	70-84*	0-69*

*Indicates limiting rule within classification.

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Objective Method of Measuring Color

A Hunter Color and Color-Difference Meter was obtained in 1950 to measure the color of both the raw and canned tomato juice during the 1950, 1951, and 1952 seasons. The Hunter Color and Color-Difference Meter was standardized before taking readings by using a tomato red porcelain tile[1] with a setting as follows: L, 25.59; a_L, + 27.40; b_L, + 12.54. A National Bureau of Standards Red Kitchen and Bathroom Tile was used to check the preliminary standardization. The meter was restandardized each half hour of operation, but rarely required readjustment.

Preparation of Samples for Hunter Color Measurement

Raw Sample. In 1950, a 10 pound sample of tomatoes of the same raw product composition as the lot being processed was used for the evaluation of color. The raw product samples were prepared for color measurement by first quartering the whole tomatoes in a deep tray in order to retain the juice lost during quartering. The quartered tomatoes and juice were then extracted in a Cefaly Pulper in order to remove seeds and peel. Due to the incorporation of air into the pureed sample, deaeration was necessary to remove the air which could have caused erroneous readings. Deaeration was accomplished in approximately 10-15 minutes by pouring the pureed samples slowly into a five liter flask under a vacuum of 25-30 inches of mercury. By alternately pulling and breaking the vacuum, the air was removed from the pureed sample. No heating was used in deaerating because it was found that this would affect the color of the raw puree.

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1. Furnished by Dr. S. G. Younkin, Campbell Soup Company

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In 1951 and 1952 seasons, the samples for color evaluation of the raw tomatoes were taken at the extractor (subsequently deaerated as described above) for the "cold break" extraction method and at the chopper (subsequently pulped in the Cefaly Pulper and deaerated as described above) for the "hot break" extraction method.

After deaeration of the sample, it was poured into a viewing cell constructed by cementing an optical glass[2] base onto 6 cm. diameter glass tubing with plastic cement.

Canned Sample. In 1950, 1951 and 1952, after the tomato juice was graded by the inspectors (6 cans per lot at each grading), a composite sample was taken from each of the cans of the same scores for color within any one lot at each cutting depending upon the color score assigned by the inspectors. In practically all cases one composite sample represented the lots.

It was not necessary to deaerate the composite samples of the processed juice. The sample was poured into a viewing cell as previously described for color measurement.

Color Measurement

Color readings in 1950, 1951 and 1952 were taken on the Hunter instrument using the small area illumination with the small aperture (1 1/16 inches in diameter). A jig was constructed and placed above the viewing aperture in such a manner that the viewing cell would always be held in the same position. All readings were taken with the Hunter Color and Color-Difference Meter using the L, a_L, and b_L scales. The Hunter a_L and b_L readings obtained for the raw and processed samples were converted to a_L/b_L color ratios.

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2. Obtained from Anchor Hocking Glass Company

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DISCUSSION OF RESULTS

The results of this grade relationship study are presented from two standpoints:

(1) by considering the raw product composition relationship to the finished product grade, taking into account the four variables, process, variety, year, and time of inspection (Tables I through VII, Appendix I), and

(2) by considering the Hunter a/b color ratio relationship of the raw product to the Hunter a/b color ratio, U.S.D.A. color score and U.S.D.A. color grade of the finished product (Tables VIII through XIV, Appendix I).

The reason for presenting the data both ways is to show the relationship that exists between the raw and finished product based on subjective grading by U.S.D.A. and, also, the relationship between raw and finished product color based on objective color evaluation as determined from the data obtained with the Hunter Color and Color-Difference Meter.

Table I (Appendix I) gives the overfall average grade for all lots of canned tomato juice by raw product composition disregarding the four variables (1) season (1949,1950, 1951, and 1952); (2) variety (Rutgers, Stokesdale and Long Red); (3) process (eight processes as described in Experimental Methods); and (4) storage (each lot was graded three times during the year except for 1952 when each lot was graded two times).

The overall average grades of all lots were in the Grade A range with the exception of Lot 12 (100 percent culls) and Lot 31 (60 percent No. 1's for color, 30 percent No. 2's for color and 10 percent No. 2's for defects) which scored in the Grade C range account flavor and the lot of 25 percent No. 1's and 75 percent No. 2's for color (No. 15) which scored in the

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Grade C range account color. In general, the data in Table I indicate that there is very little grade relationship. This is as would be expected since the four factors, variety, processing methods, seasonal variations, and storage time are not taken into consideration. These data indicate that raw product compositions are not related to the processed product grades when the above four factors are not considered.

Table II (Appendix I) presents the same data as given in Table I (Appendix I) except that the lots are classified by variety (Rutgers, Stokedale and Long Red) disregarding years, processes and times of inspection (storage) to show the effects of the three varieties on grade relationship. In most cases, the average total score of the Rutgers variety is higher than or equal to that of Stokesdale and Long Red varieties for a given raw product composition although there are exceptions in the case of Lot 9 (40 percent No. 1's for color and 60 percent No. 2's for color); Lot 12 (100 percent culls); Lot 20 (field run) and Lot 31 (60 percent No. 1's, 30 percent No. 2's for color and 10 percent No. 2's account defects). It shouldbe noted that tomato juice manufactured from the Rutgers variety had an average U.S.D.A. color score higher than the Stokedale variety (.3 to 2.3 points, except in the case of 100% culls) and the Long Red variety (.7 to 3.0 points). The data in Table II, also show that the Long Red variety has a higher average score for color than the Stokesdale variety in the lots of better than 50% No. 1's for color and 50% No. 2's for color; however, the Stokesdale variety had a higher average score than the Long Red variety below this level of raw product quality. It should be noted that the Long Red variety was only processed in 1951 and this may be due in part to seasonal difference found with the Stokesdale variety.

Table III (Appendix I) presents the data by raw product grade and year disregarding variety, process, and time of inspection to show the effect of

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different seasons on the grade relationships. Based on the overall averages, the 1950 average total scores are higher for all lots due mainly to higher average color and flavor scores. Other than this, there appears to be no general trend when comparing all seasons for any particular lot. All lots had an average score of Grade A with the following exceptions: Lot 1 (100 percent No. 1's for color in 1949, account color); Lot 8 (100 percent No. 2's for color in 1952, account color); Lot 12 (100 percent culls in 1950, account flavor); Lot 15 (25 percent No. 1's and 75 percent No. 2's for color in 1951, account color); and Lot 31 (60 percent No. 1's, 30 percent No. 2's for color, 10 percent No. 2's for defects, account flavor).

Table IV (Appendix I) presents the grade relationships of canned tomato juice by raw product grade, variety and year disregarding process and time of inspection to show the effect of the two varieties by seasons. In the case of Lot No. 1 (100 percent No. 1's) which was Grade C in 1949, it is evident from Table IV that this was due to the Stokesdale variety. By observing the data in Table IV, tomato juice made from the Rutgers variety was scored Grade A all years, and for all raw product compositions except for the three lots: Lot 8 (100 percent No. 2's for color in 1952); Lot 12 (100 percent culls in 1950); and Lot 31 (60 percent No. 1's, 30 pereent No. 2's for color, 10 percent No. 2's for defects). Tomato juice processed from the Long Red variety (1951 only) isscored Grade A with the exception of the three lots, Lot 8 (100 percent No. 2's for color; Lot 15 (25 percent No. 1's for color and 75 percent No. 2's for color); and Lot 20 (field run lot), which were Grade C account color. Tomato juice manufactured from the Stokesdale variety shows considerable discrepancy in grades assigned for lots of varying raw product composition for the different seasons. In 1949, three lots: Lot 1 (100 percent No. 1's for color); Lot 3 (75 percent No. 1's, 25 percent No. 2's for color); and Lot 31 (60 percent No. 1's, 30 percent

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No. 2's for color, 10 percent No. 2's for defects) scored in the Grade C range due to color and flavor. However, three lots in 1949: Lot 4 (75 percent No. 1's, 15 percent No. 2's for color and 10 percent No. 2's for defects; Lot 6 (60 percent No. 1's, 20 percent No. 2's for color and 20 percent No. 2's for defects); and Lot 30 (90 percent No. 1's and 10 percent No. 2's for color) scored in the Grade A range. This discrepancy may be partially explained by the fact that the No. 2's for defects (U. S. No. 1's for color) may have been of high enough color to raise the overall color slightly above the 26 points required for Grade A color; or the No. 2's for color may have been of varying color. In 1950, tomato juice manufactured from the Stokesdale variety was Grade A for all lots except Lot 12 (100 percent culls). In 1951, tomato juice manufactured from the Stokesdale variety was scored Grade C when more than 25 percent No. 2's were present in the lots processed, with the exception of Lot 15 (25 percent No. 1's and 75 percent No. 2's for color) which was scored 26.1 points for the factor of color. The Stokesdale variety was not processed in 1952.

Thus, from the above it appears that there is little effect on the grade relationship between seasons on the juice manufactured from the Rutgers variety, although season appears to have considerable effect on the grade relationship in the case of the juice manufactured from the Stokesdale variety. For the Long Red variety, data on tomato juice is available only for 1951, thus no seasonal effect can be observed. However, it should be pointed out that another variable (process) has not been considered in evaluating these data in Table IV.

Table V (Appendix I) presents the grade relationships of canned tomato juice by raw product grade, year and time of inspection disregarding process and variety. Based on the overall averages, there are no general trends.

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As can be seen in Table V, several lots of varying raw product composition had average grades of Grade C at one time of inspection and Grade A at the following inspections; the reverse of this was also true. In one case, Lot 31 (60 percent No. 1's, 30 percent No. 2's for color and 10 percent No. 2's for defects) the average grade for the lot was Grade D at the first inspection account flavor and for the following two inspections was Grade A for all factors of quality.

TABLE D. Overall Averages for U.S.D.A. Grade Factors for Canned Tomato Juice by Time of Inspection.

Factors	Averages for Inspection			Differences between Inspection Averages		
	1*	2*	3*	1* and 2*	2* and 3*	1* and 3*
Color	27.2	27.2	27.0	0.0	0.2	0.2
Absence of Defects	14.8	14.8	14.6	0.0	0.2	0.2
Consistency	13.7	13.5	13.2	0.2	0.3	0.5
Flavor	34.6	35.6	33.5	1.0	2.1	1.1
Total Score	90.6	91.2	89.8	0.6	1.4	0.8

* 1-2 months storage, 2-6 months storage and 3-10 months storage

In addition to the above discussion, Table D is presented to show the effect of time of inspection (storage) on the overall averages as calculated from Table V for the grade factors of canned tomato juice. The differences between inspection averages could be due to changes in canned tomato juice during storage or to variations in U.S.D.A. subjective grading. In no case do these differences appear to have any appreciable effect on the overall grade which was Grade A for all three inspections.

Table VI gives the grade relationship of canned tomato juice by raw product grade and process disregarding year and time of inspection to show the effect of process on grade relationships. Tomato juice manfactured as outlined in the Experimental Methods by process number 1 (cold break plate -

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pasteurized process - 2 extracts) was Grade A for all factors with the exception of Lot 8 (100 percent No. 2's for color) which was scored Grade C due to the factor of color. Process number 2 (hot break plate - pasteurized) produced tomato juice which scored in the Grade A range except for Lot 15 (25 percent No. 1's and 75 percent No. 2's for color) which was scored Grade C account color; however, Lot 8 (100 percent No. 2's) scored in the Grade A range. Process number 5 (cold break - 1 extract - Mallory) tomato juice scored in the Grade C range when more than 25 percent No. 2's for color were included in the raw product. Contrarily, tomato juice manufactured by process number 6 (hot break - Mallory) scored in the Grade A range for all raw product compositions. Process number 7 (cold break conventional process - 2 extracts) tomato juice scored in the Grade A range except for Lot 8 (100 percent No. 2's) which was Grade C account flavor. Process 8 (hot break conventional process) tomato juice scored Grade A for all lots. Process 9 (cold break plate - pasteurized - 1 extract) tomato juice was scored in the Grade A range except for Lot 15 (25 percent No. 1's and 75 percent No. 2's for color) which was Grade C account color. Process 0 (cold break conventional - 1 extract) tomato juice scored in the Grade A range for Lot 20 (field run) and in the Grade C range for Lot 8 (100 percent No. 2's for color) on account of flavor.

These data indicate that processing methods have considerable effect on the grade relationships in the case of tomato juice. It should be pointed out, however, that in Table VI (Appendix I) the variables, season and variety, are not considered which may also affect this grade relationship.

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Table VII (Appendix I) gives the grade relationship of canned tomato juice by raw product grade, process and year disregarding variety and time of inspection. Tomato juice manufactured as outlined in the Experimental Methods by process number 1 (cold break plate - pasteurized process - 2 extracts) was Grade A for all factors in 1951 and 1952 with the exception of Lot 8 (100 per cent No. 2's for color) in 1951 (Grade C account color) and 1952 (Grade C account color and flavor; and Lot 15 (25 per cent No. 1's and 75 per cent No. 2's for color) which was Grade C account color in 1952 only. Lot 15 scored in the Grade A range in Table VI before the variable of season was taken into consideration. Process number 2 (hot break - plate pasteurized) produced tomato juice which scored in the Grade A range except for Lot 15 (25 per cent No. 1's and 75 per cent No. 2's for color) which was processed only in 1951; Lot 8 which scored in the Grade A range in Table VI disregarding years, scored Grade A in 1951, but was scored in the Grade C range in 1952 account color; Lot 20 (field run) scored Grade A in Table VI and although scored Grade A in 1951, was scored in the Grade C range in 1952.

Process Number 5 (cold break - 1 extract - Mallory), process Number 6 (hot break - Mallory), process Number 7 (cold break conventional process - 2 extracts) process Number 8 (hot break conventional process) process Number 9 (cold break - plate - pasteurized - 1 extract) and process 0 (cold break conventional - 1 extract) were only studied in 1951; therefore no effect of seasonal variation can be observed.

Table E taken from Table VII (Appendix I) presents data comparing the effect of process for one season (1952) and one variety (Rutgers). These data indicate that with high quality raw products, Lot No. 1 (100 per cent No. 1's) versus low quality raw products, Lot No. 8 (100 per cent No. 2's for color) a direct grade relationship is found.

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This grade relationship is clearly indicated in total scores, however by analyzing individual scores for each attribute of quality, there is an inverse relationship between color and flavor varying with process for any one particular lot. With a cold break process, color of the canned juice is somewhat higher with high quality raw stock than for comparable lots of juice manufactured by the hot break process except for Lot 8 (100 percent No. 2's for color.)

TABLE-E. Grade Relationship for 1952 for the Rutgers Variety for the Cold Break Process (Process 1) and the Hot Break Process (Process 2)

LOT NO.	RAW PRODUCT COMPOSITION[x]	PROCESS#	TOTAL SCORE	COLOR	DEFECTS	CONSISTENCY	FLAVOR	GRADE
1	100-0-0	1	91.1	28.1	14.8	13.5	34.6	A
		2	91.3	26.9	14.9	13.8	35.6	A
3	75-25-0	1	92.7	28.2	15.0	14.7	34.8	A
		2	91.3	26.5	15.0	14.5	35.3	A
7	50-50-0	1	87.6	26.7	14.6	12.8	33.5	A
		2	90.0	26.1	14.9	14.0	35.0	A
8	0-100-0	1	83.0	24.2*	15.0	12.2	31.6*	C
		2	86.8	24.8*	14.8	13.7	33.5	C

x First number indicates per cent No. 1's; second number, percent No. 2's account color; third number, percent No. 2's account defects.

1-cold break - 2 extracts - Walker Wallace
2-hot break - Walker Wallace

* Indicates limiting rule within grade.

Conversely, with the hot break process, flavor of the canned juice is somewhat higher than for comparable lots of juice manufactured by the cold break process.

It is interesting to note from Table E, that the factor of consistency is scored practically the same for high quality lots, however, for lower quality lots, the juice manufactured by the cold break process is scored lower for the factor of consistency than comparable lots of juice manufactured by the hot break process.

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The second method of presenting these data is to discuss by variety, process, and year the relationship of the a/b color ratio of the raw product to the a/b color ratio of the finished product and the U.S.D.A. Color Score and Color Grade. In all of the following discussion, U.S.D.A. raw product grade has been disregarded and the raw product has been classified on the basis of a/b color ratios.

Table VIII (Appendix I) presents the overall average Hunter a/b color ratio for the raw product as well as the a/b color ratio of the finished product and the U.S.D.A. Color Score and Color Grade. These data show that there is an almost direct relationship between the a/b color ratio of the raw product and the a/b color ratio of the canned product.

Average U.S.D.A. Color Scores for the processed product show a good relationship with the a/b color ratios of both raw and canned products. It should be noted that a raw product a/b color ratio of between 1.80 and 1.90 (1.85) is required to obtain Grade A tomato juice for color; likewise, an a/b color ratio above the range of 1.57 to 1.60 for canned tomato juice would be necessary to score U.S. Grade A for Color.

Table IX (Appendix I) presents the data as given in Table VIII (Appendix I) except the data are further classified by variety. Observation of these data show that variety and original raw product a/b color ratio both have a direct effect on canned tomato juice a/b color ratio, a/b color ratio loss, average U.S.D.A. Color Score and Grade. Specifically, the Stokesdale variety had a lower a/b color ratio loss and thus a higher finished product a/b color ratio than the varieties Long Red or Rutgers in every group with the exception of the 2.20 to 2.29 a/b color ratio group.

It should be noted from these data that with increasing raw product a/b color ratio, there is an increasing a/b color ratio loss regardless of the varieties used in this study.

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Under these pilot plant conditions, tomato juice manufactured from the Long Red variety shows a greater a/b color ratio loss than Rutgers or Stokesdale varieties. In all cases, except the 2.30 to 2.39 a/b color ratio grouping, the a/b color ratio of tomato juice from the Long Red variety had a lower a/b color ratio. Above the range of 2.30 a/b color ratio, an interesting observation is noted. That is, the a/b color ratio of the canned tomato juice remains essentially constant in spite of the increasing a/b color ratio of the raw product. The same is true of the U.S.D.A. Color Score for the finished product.

Table X (Appendix I) presents data for the overall Hunter a/b color ratio values for the raw product, the a/b color ratio of the finished product, the U.S.D.A. Color Score and U.S.D.A. Color Grade classified by year. Color measurement data for the years 1950,1951 and 1952 only are given. It can be seen from Table X, in general, the a/b color ratio loss for 1951 was more than in 1950 and the a/b color ratio loss in 1952 was more than in 1951. These data show that a specific raw product a/b color ratio may not necessarily result in the same a/b color ratio of the canned tomato juice every season. In 1950 an average raw product a/b color ratio of 1.75 was required to give Grade A canned tomato juice, while in 1951 an average a/b color ratio of 2.04 was required, and in 1952, an average a/b color ratio 1.94, thus indicating a somewhat different color relationship for the three years.

Table XI (Appendix I) presents the overall Hunter a/b color ratio for the raw product, the a/b color ratio of the finished product, and the U.S.D.A. Color Score and U.S.D.A. Color Grade by year and variety, disregarding process and time of inspection.

Varietal differences can be observed in Table XI (Appendix I) with respect to a/b color ratio loss. In general, the Stokesdale variety shows a lower a/b color ratio loss than Rutgers or Long Red; however, neither in 1950 nor in 1951 was a raw product a/b color ratio higher than 2.40 obtained with the Stokesdale

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variety. The Long Red variety appears to have an a/b color ratio loss similar to the Rutgers when comparing the 1951 season only, with the exception that Long Red tomatoes of lower color (1.6 to 2.0 a/b color ratio groups) appear to exhibit a slightly greater color loss than the Rutgers variety at equivalent raw product a/b color ratios.

In general, there appears to be a good relationship between raw product a/b color ratio and U.S.D.A. Color Score assigned the canned product. A raw product a/b color ratio between 1.57 and 1.65 can be expected to produce minimum Grade C tomato juice using the Stokesdale variety. In the case of the Long Red variety a raw product a/b color ratio slightly higher than 1.65 is indicated to be necessary for Grade C tomato juice (23 to 25 points) although one lot of Long Red tomato juice with this initial color ratio only scored 22.7 points on U.S.D.A. Color Score. There was no Grade D. juice produced from the Rutgers variety in any season. The lowest color ratio of 1.67 in 1952 produced juice with an average score of 23.6 for color, or slightly above the Grade C minimum value of 23 score points.

With respect to raw product a/b color ratio required for each of the above three varieties to produce Grade A tomato juice for color, the Stokesdale variety in 1951 with a raw product a/b color ratio of 1.65 produced juice which scored minimum Grade A for color. However, in 1950, a raw product a/b color ratio of 1.62 produced Grade C juice for color, and an a/b color ratio of 1.76 produced Grade A juice for color. One discrepancy can be noted with juice made from the Stokesdale variety. In 1951, a raw product a/b color ratio of 1.77 produced a tomato juice of 1.19 color ratio which was Grade D for color. This could be due to process, as will be pointed out later in Tables XIII and XIV (Appendix I).

The data for the Rutgers variety show little difference to exist between seasons and an a/b color ratio of approximately 1.90 or greater is required to produce tomato juice of minimum Grade A for the factor of color.

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The Long Red variety, processed only in 1951, required a 2.06 a/b color ratio of the raw product to produce tomato juice that was minimum Grade A for color (26.0 points).

Table XII (Appendix I) presents the data classified by year and time of inspection disregarding variety and process. In general, the data in Table XIII show that after 6 months storage there is a decrease in the average a/b color ratio of the canned product as compared to the average a/b color ratio after 2 months storage. After 10 months storage, in most cases, the a/b color ratio increased to a value higher than the original reading after 2 months storage. Although the U.S.D.A. Color Score follows a similar trend in some cases, it appears to be the exception rather than the rule. Of most importance to the processor are the cases where the U.S.D.A. Color Grade (A,C, or D) changed upon storage and if there was a corresponding change in the a/b color ratio. Only these cases are reproduced in Table F, in all other cases, the U.S.D.A. Color Grade was the same for all three inspections. There were only four cases (Table F) out of thirty-four (Table XII) where the U.S.D.A. Color Grade increased or decreased. In all cases, a raw product a/b color ratio of 2.0 or higher produced tomato juice of Grade A color, with corresponding a/b color ratio of 1.55 or higher on the canned product.

It is of interest to note that in no case in the 1952 grading (only two inspections) was there a case where there was a change in color grade in the critical a/b color ratio range (between A and C). During the 1952 season, all samples were graded under a standardized light source (the light source is composed of two R40 300 watt reflector flood lamps used with two 7 1/4 inch Macbeth daylight filters and mounted in a unit enclosed with a special non-selective diffusing glass.) and using standardized Munsell matching disks, whereas in 1951 only the light source was standardized and in 1950 there was no control of lighting or disks.

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Table F. Changes in U.S.D.A. Color Grade, Canned Product a/b Color Ratio and U.S.D.A. Color Score by a/b Color $R_a$tio Group, Year and Time of Inspection from Table XII (Appendix I).

a/b Color $R_a$tio Group°	Year	Inspection#	CANNED PRODUCT Averages a/b Color Ratio	Average U.S.D.A. Color Score	Color Grade
1.6	1950	1	1.45	25.0	C
		2	1.37	27.0	A
		3	1.8	24.0	C
1.7	1951	1	1.14	15.0	D
		3	1.23	23.0	C
1.8	1951	1	1.56	26.5	A
		2	1.48	25.7	C
		3	1.66	25.2	C
1.9	1951	1	1.58	26.4	A
		2	1.52	25.8	C
		3	1.58	25.5	C

° - All lots grouped on raw product a/b ratio values. 1.6 group includes all lots 1.60 to 1.69. 1.7 group includes all lots 1.70 to 1.79, etc.

\# - Inspection (1 -After two months storage; 2 - After 6 months; 3 - After 10 months).

Table XIII (Appendix I) presents the data classified by process disregarding variety, year and time of inspection. These data indicate that with "Hot Break" (process 2) processed tomato juice less color loss, as measured by the a/b color ratio, occurs in the lower a/b color ratio raw product groupings (1.6 to 1.9) than with the juice manufactured by the "Cold Break" (process 1) process. However with a raw product a/b color ratio of 2.0 or above, neither "Cold Break" (process 1) nor "Hot Break" (process 2) tomato juice appear to show any consistent trends. These data are not conclusive, due to the fact that variety may have some influence on the a/b color ratios as has been previously shown and as the data in Table XIV (Appendix I) indicate.

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Table XIV (Appendix I) presents the data classified by process, variety, and year disregarding time of inspection. These data in Table XIV (Appendix I) explain many of the differences observed in the grade relationship. In this table, the three most important variables; process, variety, and seasons are taken into consideration to show their individual effect on the color relationship of raw product to finished product.

The data in Table G taken from Table XIV (Appendix I) are presented to show the effect of season on the color relationship for the Rutgers variety when canned tomato juice was manufactured using Process 1 (cold break plate-pasteurized 2 extracts).

Table G. Color Relationship between Hunter a/b Color Ratios of Raw Tomato Juice, Canned Tomato Juice and U.S.D.A. Color scores and Color Grades for Process 1 (cold break plate-pasteurized - 2 extracts), Rutgers Variety and for the Three Seasons, 1950, 1951, and 1952.

a/b Color Ratio Group°	Year	Average a/b Color Ratio (Raw Product)	Average a/b Color Ratio (Canned Product)	Average a/b Color Ratio Loss	Average U.S.D.A. Color Score	Average U.S.D.A. Color Grade
1.6	1952	1.61	1.24	.37	21.0*	D
1.7	1952	1.74	1.42	.32	25.0*	C
1.8	1950	1.83	1.51	.32	25.7*	C
	1951	1.81	1.62	.19	25.5*	C
	1952	1.85	1.33	.52	25.5*	C
1.9	1951	1.94	1.68	.26	27.2	A
	1952	1.94	1.53	.41	26.6	A
2.0	1950	2.02	1.69	.33	26.7	A
	1951	2.05	1.73	.32	27.4	A
	1952	2.06	1.59	.45	26.6	A

o - All lots grouped on a/b ratio values. 1.6 group includes all lots 1.60 to 1.69, 1.7 group includes all lots 1.70 to 1.79, etc.

* - Indicates limiting rule within grade.

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From these data, it is evident that a raw product a/b color ratio between 1.61 and 1.74 was required to produce minimum Grade C tomato juice for color in 1952. These data also show that a raw product a/b color ratio in the 1.90 a/b color ratio range was required to produce Grade A canned tomato juice for color.

In addition, these data indicate that season affects the color relationship. With equivalent raw product a/b color ratio values, the a/b color ratios of the canned product and the U.S.D.A. Color Scores tended to be lower in 1952 than in 1950 or 1951.

The data in Table H taken from Table XIV (Appendix I) is presented to show the effedt of season on the color relationship for the Rutgers variety when

Table H. Color Relationship between Hunter a/b Color Ratios of Raw Tomato Juice, Canned Tomato Juice and U.S.D.A. Color Scores And Color Grades for Process 2 (hot break plate-pasteurized), Rutgers Variety and for the Two Seasons, 1951 and 1952.

a/b Color Ratio Group[o]	Year	Average a/b Color Ratio (Raw Product)	Average a/b Color Ratio (Canned Product)	Average a/b Color Ratio Loss	Average U.S.D.A. Color Score	Average U.S.D.A. Color Grade
1.6	1952	1.69	1.45	.24	24.2*	C
1.8	1951	1.82	1.60	.22	26.7	A
	1952	1.88	1.58	.30	25.8	C
1.9	1951	1.92	1.66	.26	27.0	A
2.0	1951	2.04	1.76	.28	27.7	A
	1952	2.06	1.51	.55	25.8*	C
2.1	1951	2.15	1.88	.27	28.0	A
	1952	2.14	1.52	.62	26.5	A

o - All lots grouped on a/b ratio values. 1.6 group includes all lots 1.60 to 1.69, 1.7 group includes all lots 1.70 to 1.79, etc.

* - Indicates limiting rule within grade.

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canned tomato juice was manufactured using Process 2 (hot break plate-pasteurized). These data show that season had considerable effect on the color relationship in the case of this hot break process, since in 1951 an average raw product a/b color ratio of 1.82 produced Grade A tomato juice for color, while in 1952 an average a/b raw product a/b color ratio of 2.14 was required to obtain Grade A tomato juice for color. It should also be pointed out that with equivalent raw product a/b color ratios, the U.S.D.A. score for color was lower in 1952 than in 1951.

The data in Table I, taken from Table XIV(Appendix I) show the effect of variety on the color relationship for the 1951 season only when canned tomato juice was manufactured using Process 1(cold break plate-pasteurized - 2 extracts).

The raw product a/b color ratio required to produce Grade A tomato juice from the Rutgers variety with this process has been considered in the discussion of Table G. For the Long Red variety, an a/b raw product color ratio between 1.65 and 1.81 was required to produce minimum Grade C tomato juice for color. Also, between a 1.92 and 2.06 a/b raw product color ratio was required to produce Grade A tomato juice for color. In general, there was a greater a/b color ratio loss during processing for the Long Red variety than for either Rutgers or Stokesdale varieties in 1951 using Process 1.

There were not sufficient lots of the Stokesdale variety for this particular process to determine the dividing line between Grade C and Grade D. To produce miniumumGrade A tomato juice, it appears that raw product a/b color ratio of 1.94 or above would be required.

From the above discussion of these data, therefore, it appears that when using Process 1, a slightly higher raw product a/b color ratio of the Long Red variety was required in 1951 to produce Grade A tomato juice than for the Rutgers variety. Also, to produce Grade A canned tomato juice a slightly higher raw product a/b color ratio was required for the Stokesdale variety than either Long Red or Rutgers varieties.

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Table I. Color Relationship between Hunter a/b Color Ratios of Raw Tomato Juice, Canned Tomato Juice and U.S.D.A. Color Scores and Color Grades for Process 1 (cold break plate-pasteurized - 2 extracts) for the Stokesdale, Rutgers, and Long Red varieties, for the 1951 season only.

a/b Color Ratio Group°	Variety#	Average a/b Color Ratio (Raw Product)	Average a/b Color Ratio (Canned Product)	Average a/b Color Ratio Loss	Average U.S.D.A. Color Score	Color Grade
1.6	L	1.65	1.30	.35	22.7*	D
1.8	R	1.81	1.62	.19	25.5*	C
	L	1.85	1.46	.39	24.8*	C
1.9	S	1.92	1.65	.27	25.7*	C
	R	1.94	1.68	.26	27.2	A
	L	1.92	1.40	.52	24.9*	C
2.0	R	2.05	1.73	.32	27.4	A
	L	2.06	1.56	.50	26.4	A
2.1	R	2.15	1.73	.42	28.0	A
	L	2.15	1.67	.48	27.1	A
2.2	S--	2.20	1.73	.47	27.0	A
	R	2.25	1.77	.48	27.8	A
	L	2.26	1.55	.71	26.3	A
2.3	R	2.33	1.86	.47	28.6	A
	L	2.37	2.02	.35	28.7	A
2.4	R	2.43	1.77	.66	27.9	A

o - All lots grouped on a/b color ratio values. 1.6 group includes all lots 1.60 to 1.69, 1.8 group includes all lots 1.80 to 1.89, etc.

- S (Stokesdale); R (Rutgers); L (Long Red).

* - Indicates limiting rule within grade.

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The effect of the "cold break" (Process 1) and "hot break" (Process 2) processes on the color grade relationship can be observed in Table XIV (Appendix I). Tomato juice manufactured from the Rutgers variety using "cold break" (Process 1) required a 1.94 raw product a/b color ratio to produce Grade A tomato juice for color, while a 1.82 raw product value produced Grade A tomato juice for color when using the "hot break" (Process 2). Conversely, it appears that a slightly higher (2.16) a/b color ratio of the raw product for the Long Red variety was required to produce Grade A tomato juice for color using "hot break" (Process 2), than when using the "cold break" (Process 1) (between 1.92 and 2.16 was required) process. In the case of the Stokesdale variety, these data indicate that a raw product a/b color ratio in the 1.90 to 1.99 range produced Grade A tomato juice for color using either "cold break" (Process 1) or "hot break"(Process 2). Thus, since color of canned tomato juice is one of the more important factors of U.S.D.A. Grades, tand since a product scoring Grade C or Grade D for color can score no higher than the grade assigned for the factor of color (limiting rule), the color relationship would have an important bearing on the grade relationship.

More evidence that the effect of the variable of process must be taken into consideration in the grade relationship of tomato juice is shown in Table XIV (Appendix I) which gives the color relationship data for all processes by year (1950, 1951 and 1952) and for the Rutgers, Stokesdale and Long Red varieties respectively. A general conclusion drawn from these data is that any particular process had considerably more effect on the color relationship in the case of the Stokesdale variety than in the case of the Long Red or Rutgers variety and the Long Red variety was affected more by any particular process than was the Rutgers variety.

Yield Relationship. The relationships of yield of raw tomato juice, prior to processing, to raw product composition, variety, and process are

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presented in Table XV (Appendix I) for 1951 and 1952. The variable of year (season) was eliminated since there was no discernible effect of year on the yield values. Before discussing these data, it should be pointed out that they were obtained on small lots and under pilot plant conditions. In the cases where tomato pulp was made from part of the lot, 400 to 1000 pound lots were processed. Other lots were 100 and 200 pound lots. In interpreting these data, it should be kept in mind that under these pilot plant conditions:

(1) All cull fruits were eliminated before entering the plant.

(2) Generally speaking, relatively high grades of raw stock were used.

(3) For tomato juice studies, none of the tomatoes in any of the lots were trimmed.

(4) Due to small lots being processed in the pilot plant, any small loss of product would be greatly magnified when converting to ton or case equivalents.

Table J, taken from Table XV (Appendix I) presents the yield data for the Rutgers variety for the 1951 and 1952 seasons by raw product composition and for Process 1 (cold break - 2 extracts - plate-pasteurized) and for Process 2 (hot break - plate-pasteurized). These data show no correlation in yield data by raw product composition for either Process 1 or Process 2. This is probably as would be expected since, as stated above, none of the tomatoes in any of the lots were trimmed.

In these studies, the most important variable affecting yield relationship was that of process.

Table K gives the yeld data taken from Table XV (Appendix I) by process disregarding raw product composition, year, and variety.

Process 1 and 2 represent 72% of the lots processed, or 94 and 67 lots respectively. When comparing Process 1 (cold break - 2 extracts - plate-pasteurized) to Process 2 (hot break - plate-pasteurized), these data indicate that

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Table J. Yield Relationship by Raw Product Composition, Process and Year in Percent Yield of Raw Juice Prior to Processing for 1951 and 1952 for the Rutgers Variety only.

Lot	Raw Product Composition[x]	Process#	Percent Average Yield of Raw Juice
1	100-0-0	1	79.9
		2	80.0
2	0-100-0	1	77.0
3	75-25-0	1	78.0
		2	76.8
7	50-50-0	1	78.1
		2	81.6
8	0-100-0	1	81.0
		2	77.7
10	0-0-100	1	80.7
		2	75.0
13	75-0-25	1	79.0
		2	78.8
14	50-50-0	1	82.3
		2	77.2
15	25-75-0	1	75.5
		2	82.0
16	25-0-75	1	86.0
20	Field Run	1	75.4
		2	81.0
21	0-100-0	1	81.0
22	100-0-0	1	83.0
23	100-0-0	1	84.0

- 1 Cold Break - 2 Extracts - Walker Wallace
2 Hot Break - Walker Wallace

x - 1st No. inicates % No. 1's; 2nd No. % No. 2's account color; 3rd No. % No. 2's account defects.

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Table K. Yield Relationship by Process Disregarding Raw Product Composition, Year (1951 and 1952), and Variety.

Process#	Percent Overall Average Yield
1	78.5
2	79.2
5	69.4
6	77.9
7	78.2
8	79.5
9	64.7
0	60.7

\# - 1 Cold Break - 2 Extracts - Walker Wallace
2 Hot Break - Walker Wallace
5 Cold Break - 1 Extract Mallory
6 Hot Break - Mallory
7 Cold Break - 2 Extracts - Conventional cook
8 Hot Break - Conventional cook
9 Cold Break - 1 Extract - Walker Wallace
0 Cold Break - 1 Extract - Conventional cook

there was only a slightly higher yield (.7%) for Process 2 under these pilot plant conditions. As outlined in the discussion of Table E, both "cold break" and "hot break" processes offer certain advantages. From the discussion of Table K, there appears to be little difference in the yields obtained by using these two processes. Therefore, from the discussion of Table E, it would seem that, in general, a higher quality canned tomato juice could be manufactured from high quality raw stock by using the "cold break" process (Process 1), while a higher quality canned tomato juice could be manufactured from lower quality raw stock by using the "hot break" process (Process 2).

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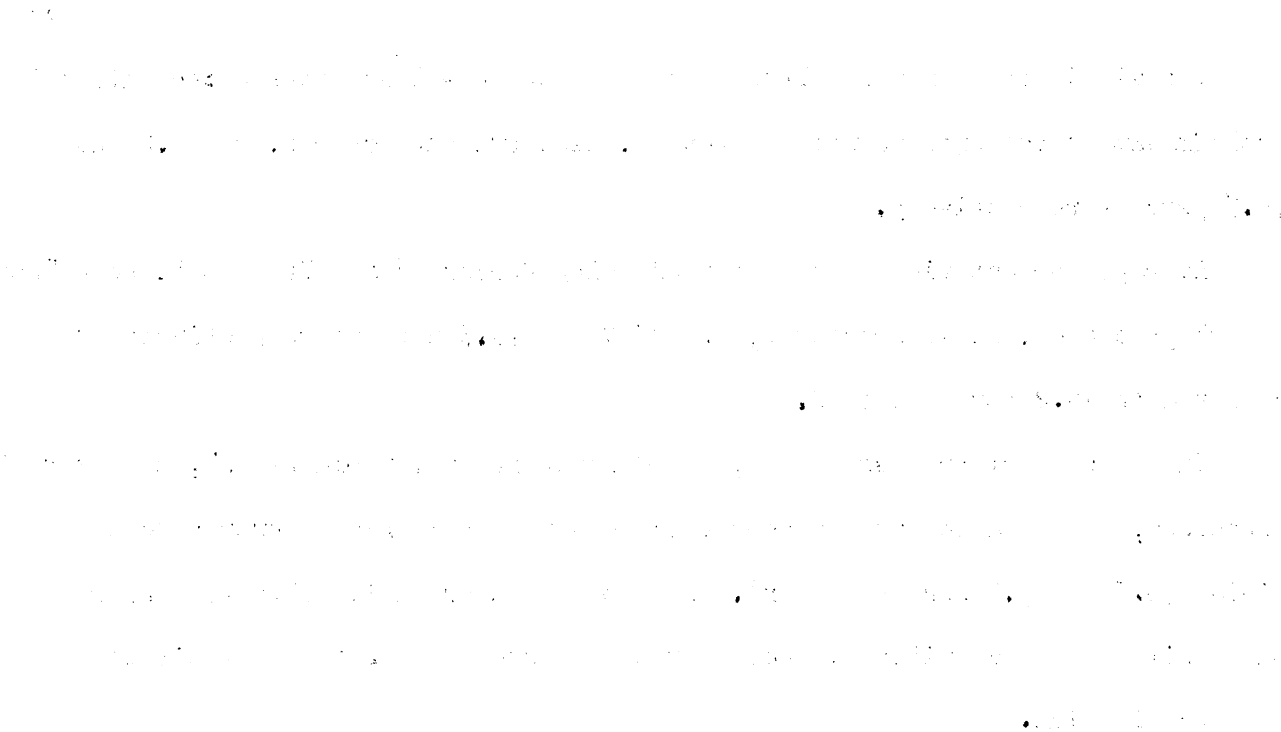
The yield obtained using Process 7 (cold break - 2 extracts - conventional cook) is almost the same as with Process 1, also two extractions, or 78.2 and 78.5 percent respectively.

Average percent yield data obtained using Process 6 and Process 8, both "hot break" processes, as is Process 2, are 77.9 and 79.5 percent respectively as compared to 79.2 for Process 2.

In the dase of processes 5, 9, and 0 which are all "cold break", one extract processes, the data in Table K show them to have considerably lower percent yields (8.5 to 18.8 percent lower). Due to the lower yields obtained under these pilot plant conditions, these three processes appear to be of little commercial value.



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SUMMARY

1. The relationship of raw grade to processed grade shows that a Processor can generally expect to pack Grade A or Fancy tomato juice from tomatoes of a raw product composition of 60 percent No. 1's, 20 percent No. 2's for color and 10 percent No. 2's for defects or better. There are exceptions to this grade relationship depending on the variables of variety, process or season.
2. In these studies on the relationship of raw grades of tomatoes to processed grades of canned tomato juice a better grade relationship was obtained when the factors variety, processing methods, and seasonal variations were considered. This relationship was further improved when the grade of the raw product was established by objectively determining the color of one raw product.
3. On the basis of average total scores and average color scores obtained on canned tomato juice processed from raw product of equivalent quality, generally the Stokesdale variety was found to be inferior to the Rutgers and Long Red varieties, and generally the Long Red variety was found to be inferior to the Rutgers variety.
4. The variable of season (year) had little effect on the grade relationship when manufacturing canned tomato juice from the Rutgers variety.
5. By classifying the lots on the basis of Hunter a/b color ratio groups of the raw product, there was a direct relationship between raw product color values, a/b color ratios of canned tomato juice and U.S.D.A. color scores.
6. In terms of the Hunter a/b ratio relationship of raw product to finished product, the "cold break" process (2 extracts - plate-pasteurized) was found to give higher quality canned tomato juice than the "hot break" process (plate-pasteurized) when using a raw product of high quality. The reverse of this was found with a raw product of lower quality; that is,

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the "hot break" process (plate-pasteurized) produced canned tomato juice of higher quality than the "cold break" process. In general, the effect of process on the grade relationship was not appreciable when using the Rutgers variety; however, in the dase of the Stokesdale and Long Red varieties, the variables of process affected the grade relationship materially.

7. There was a direct relationship between the U.S.D.A. Color Score for canned tomato juice and the Hunter a/b color ratio of canned tomato juice.

8. In general, with increasing raw product color (Hunter a/b color ratios), there was an increasing a/b color ratio loss between the a/b color ratio of the raw product and the a/b color ratio of the canned tomato juice.

9. Little difference was found due to the time of inspection (2, 6 and 10 months storage, except in 1952 when only two inspections were made after 1 and 5 months storage) with respect to U.S.D.A. total scores and scores assigned for the factors of color , consistency, absence of defects and flavor. With regard to objective color measurements, in general, the Hunter a/b color ratio data indicated a decrease in color from 2 to 6 months storage, while an increase in color was indicated from 6 to 10 months storage. The Hunter a/b color ratio value at 10 months storage was slightly better than the original value at 2 months storage.

10. On the basis of overall averages disregarding variety, season, process and time of inspection, a Hunter a/b color ratio for the raw product above the range of 1.60 to 1.69 was required to produce minimum Grade C canned tomato juice for the U.S.D.A. grade factor of color. A raw product a/b color ratio between 1.85 and 1.95 was required to obtain minimum Grade A tomato juice for color.

11. Based on the Hunter a/b color ratios for canned tomato juice and average U.S.D.A. Color Scores, the dividing line between Grade C and Grade D for

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the score factor of color was found to be in the range of 1.24 to 1.44 and the dividing line between Grade A and Grade C for the score factor of color was found to be in the range of 1.52 to 1.68

12. Under the pilot plant conditions of this study, there was little relationship between yield and raw product grade. Further, little difference in the overall average yields of tomato juice were found between the "cold break" process (2 extracts) and the "hot break" process.

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CONCLUSIONS

On the basis of this study of canned tomato juice it is conculuded that there is a better grade relationship between the raw product grade and the finished product grade when the following four factors are considered: (1) variety (2) process, (3) season, and (4) objective color evaluation of the raw product. The two variables having the greatest effect on the grade relationship were process and variety. Under these pilot plant conditions where both of these variables, variety and process, were known, the finished product grade of tomato juice could be predicted from the original raw product grade. Further, when the raw product color grade was interpreted in terms of Hunter a/b color ratios, the grade relationship was materially improved.

The development of the Macbeth-Munsell Disk Colorimeter was an outgrowth of this study on the grade relationship of raw tomatoes to grades of canned tomato juice. Two of the basic principles of color were incorporated in the Macbeth-Munsell Disk Colorimeter, that is, (1) controlled and uniform lighting and (2) the use of standard disks with their location standardized with respect to lighting, sample and observer. Variations in subjective color evaluations of canned tomato juice were reduced in the 1952 season when all juice was graded with the disk colorimeter. In no case was there a change in color grade during the 1952 season in the critical a/b color ratio range (between Grade A and Grade C).

Based on this study of tomato juice, the Hunter Color and Color-Differenc Meter (a/b color ratio) can be used as an objective method for: (1) determining the original raw product color; (2) quality control (color measurement) during processing; and (3) determining the color score of canned tomato juice. The a/b color ratio of the raw product was found to be more specific for predicting the color of the canned tomato juice than was the actual grade composition of the raw product.

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RECOMMENDATIONS

To improve the relationship between the raw product grade and the finished product grade of tomato juice it is recommended that the grading of raw tomatoes for manufacture of tomato juice be based on the objective color evaluation of the extracted pulp from the raw tomatoes.

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Appendix I

- Tabular Data -

Quality and Yield Relationships of Canned Tomato Juice

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TABLE I Grade Relationship of Canned Tomato Juice by Raw Product Grade Disregarding year, variety, process and Time of Inspection.

Lot No.	Raw Product Composition[x]	Can Count	Total Score	Color	Defects	Consis-tency	Flavor	Grade
1	100-00-0	1349	91.1	27.5	14.7	13.5	35.4	A
3	75-25-0	558	91.5	27.2	14.8	13.9	35.6	A
4	75-15-10	240	91.8	27.7	14.9	13.8	35.5	A
5	60-40-0	144	93.3	28.0	15.0	13.6	36.8	A
6	60-20-20	205	91.4	27.7	14.7	13.4	35.5	A
7	50-50-0	541	90.7	27.0	14.8	13.5	35.4	A
8	0-100-0	912	88.4	26.2	14.4	13.2	34.5	A
9	40-60-0	162	91.3	27.3	14.9	13.7	36.4	A
12	100 culls	54	88.2	27.2	14.8	13.4	32.6*	C
13	75-0-25	144	92.8	28.1	14.9	13.5	36.4	A
14	50-0-50	120	92.8	27.8	15.0	13.7	36.3	A
15	25-75-0	171	88.6	25.9*	14.7	13.5	34.6	C
20	Field Run	694	90.9	27.3	14.7	13.5	35.5	A
30	90-10-0	108	90.9	27.1	14.9	14.0	35.1	A
31	60-30-10	96	82.1	26.1	14.8	12.2	31.3*	C

x - 1st No. indicates % No. 1's; 2nd No. % No. 2's account color; and 3rd No. % No. 2 account defects.

* - Indicates limiting rule within grade.

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TABLE II Grade Relationship of Canned Tomato Juice by Raw Product Grade and Variety Disregarding Year, Process and Time of Inspection.

Lot No.	Raw Product Composition[x]	Variety[#]	Can Count	Total Score	Color	Defects	Consistency	Flavor	Grade
1	100-0-0	S	382	87.1	26.2	14.6	13.0	33.6	A
		R	807	92.8	28.2	14.8	13.8	36.1	A
		L	160	91.4	27.5	14.7	13.6	35.7	A
3	75-25-0	S	192	88.7	26.4	14.8	13.4	34.1	A
		R	312	92.9	27.8	14.7	14.0	36.4	A
		L	54	92.9	27.0	14.9	14.8	36.2	A
4	75-15-10	S	126	91.0	27.4	15.0	13.9	34.8	A
		R	114	92.6	27.9	14.9	13.6	36.2	A
5	60-40-0	S	72	93.3	27.4	14.9	14.3	36.7	A
		R	72	93.3	28.7	15.0	12.8	36.9	A
6	60-20-20	S	109	91.3	27.4	15.0	14.0	35.0	A
		R	96	91.6	28.1	14.5	12.9	36.1	A
7	50-50-0	S	108	90.4	26.7	14.8	13.5	35.4	A
		R	349	91.0	27.3	14.8	13.3	35.6	A
		L	84	89.6	26.2	14.7	14.1	34.6	A
8	0-100-0	S	306	87.8	25.9*	14.7	13.5	33.8	C
		R	414	89.4	26.6	14.3	13.2	35.3	A
		L	192	86.9	25.8*	14.3	12.8	33.9	C
9	40-60-0	S	72	92.7	27.0	14.9	14.2	36.5	A
		R	90	92.1	27.6	14.9	13.3	36.3	A
12	100 culls	S	36	89.3	28.0	15.0	13.5	32.8*	C
		R	18	86.0	25.7*	14.3	13.3	32.3*	C
13	75-0-25	R	144	92.8	28.1	14.9	13.5	36.4	A
14	50-0-50	R	120	92.8	27.8	15.0	13.7	36.3	A
15	25-75-0	S	54	88.2	26.1	14.6	13.3	34.2	A
		R	48	93.0	27.5	14.9	13.8	36.9	A
		L	69	85.9	24.7*	14.8	13.5	33.3	C
20	Field Run	S	36	92.5	27.3	14.5	14.3	36.3	A
		R	605	91.3	27.6	14.7	13.5	35.6	A
		L	53	85.7	24.6*	14.5	13.1	33.4	C
30	90-10-0	S	54	89.6	26.6	14.9	13.9	34.6	A
		R	54	92.2	27.6	14.8	14.1	35.6	A
31	60-30-10	S	54	84.4	25.1*	14.9	12.5	31.4*	C
		R	42	79.2	27.4	14.7	11.8	31.2*	C

x - 1st No. indicates % No. 1's; 2nd No. % No. 2's account color; and 3rd No. % No. 2 account defects.
- S (Stokesdale); R (Rutgers); L (Long Red)
* - Indicates limiting rule within grade.

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TABLE III Grade Relationship of Canned Tomato Juice by Raw Product Grade and Year Disregarding Variety, Process and Time of Inspection.

Lot No.	Raw Product Composition[x]	Year	Can Count	Total Score	Color	Defects	Consis-tency	Flavor	Total Grade
1	100-0-0	49	144	86.4	25.8*	14.8	13.0	33.0	C
		50	144	94.4	28.8	15.0	13.1	37.5	A
		51	914	91.4	27.6	14.6	13.7	35.4	A
		52	147	91.1	27.7	14.8	13.6	35.0	A
3	75-25-0	49	108	88.6	26.2	14.9	13.4	34.1	A
		50	144	94.4	28.4	14.9	14.0	37.3	A
		51	246	90.8	27.0	14.6	13.9	35.4	A
		52	60	92.1	27.5	15.0	14.6	35.0	A
4	75-15-10	49	114	90.3	27.1	14.8	13.8	34.6	A
		50	126	93.1	28.1	15.0	13.7	36.2	A
5	60-40	50	144	93.3	28.0	15.0	13.6	36.8	A
6	60-20-20	49	79	89.4	26.7	14.4	13.4	34.9	A
		50	126	92.6	28.3	14.9	13.5	35.9	A
7	50-50-0	50	162	92.7	27.9	15.0	13.4	36.3	A
		51	246	90.4	26.7	14.7	13.6	35.4	A
		52	133	88.7	26.4	14.7	13.3	34.2	A
8	0-100-0	50	126	89.7	26.5	13.9	13.7	35.7	A
		51	720	88.4	26.3	14.5	13.2	34.4	A
		52	66	85.1	24.5*	14.9	13.0	32.6*	C
9	40-60	50	162	92.3	27.3	14.9	13.7	36.4	A
12	100 culls	50	54	88.2	27.2	14.8	13.4	32.6*	C
13	75-0-25	51	72	92.8	28.4	14.8	12.7	36.8	A
		52	72	92.9	27.8	15.0	14.3	35.9	A
14	50-0-50	51	36	92.8	28.5	15.0	13.0	36.3	A
		52	84	92.7	27.5	15.0	14.0	36.2	A
15	25-75-0	51	171	88.6	25.9*	14.7	13.5	34.6	C
20	Field Run	51	550	91.3	27.5	14.6	13.5	35.7	A
		52	144	89.5	26.6	14.8	13.4	34.7	A
30	90-10-0	49	108	90.9	27.1	14.9	14.0	35.1	A
31	60-30-10	49	96	82.1	26.1	14.8	12.2	31.3*	C

x - 1st No. indicates % No. 1's; 2nd No. % No. 2's account color; and 3rd No. % No. 2 account defects.

* - Indicates limiting rule within grade.

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TABLE IV Grade Relationship of Canned Tomato Juice by Raw Product Grade, Year and Variety, Disregarding Process and Time of Inspection.

Lot No.	Raw Product Composition[x]	Year	Variety[#]	Can Count	Total Score	Color	Defects	Consistency	Flavor	Grade
1	100-0-0	49	S	72	81.2	24.2*	14.8	12.1	30.4*	C
			R	72	91.6	27.4	14.8	13.9	35.6	A
		50	S	54	93.9	28.0	15.0	13.6	37.3	A
			R	90	94.8	29.2	15.0	12.9	37.7	A
		51	S	256	87.7	26.4	14.4	13.2	33.8	A
			R	498	93.2	28.2	14.7	14.0	36.2	A
			L	160	91.4	27.5	14.7	13.6	35.7	A
		52	R	43	91.3	27.2	14.8	13.3	35.9	A
3	75-25-0	49	S	72	86.3	25.7*	14.8	13.0	32.7*	C
			R	36	93.3	27.3	15.0	14.2	36.8	A
		50	S	72	94.1	28.0	14.8	14.3	37.1	A
			R	72	94.8	28.8	14.9	13.8	37.4	A
		51	S	48	84.3	25.0*	14.8	12.8	31.8*	C
			R	144	92.3	27.6	14.5	13.9	36.4	A
			L	54	92.9	27.0	14.9	14.8	36.2	A
		52	R	60	92.1	27.5	15.0	14.6	35.0	A
4	75-15-10	49	S	54	89.2	26.7	14.9	13.7	34.1	A
			R	60	91.3	27.5	14.8	14.0	35.1	A
		50	S	72	92.3	27.9	15.0	14.1	35.3	A
			R	54	94.1	28.4	15.0	13.2	37.4	A
5	60-40-0	50	S	72	93.3	27.4	14.9	14.3	36.7	A
			R	72	93.3	28.7	15.0	12.8	36.9	A
6	60-20-20	49	S	37	89.9	26.2	15.0	14.2	34.6	A
			R	42	89.0	27.2	14.0	12.7	35.1	A
		50	S	72	92.0	28.0	15.0	13.8	35.1	A
			R	54	93.5	28.8	14.9	13.0	36.8	A
7	50-50-0	50	S	72	93.2	27.6	15.0	14.0	36.6	A
			R	90	92.3	28.2	15.0	12.9	36.1	A
		51	S	36	84.8	25.0*	14.5	12.5	32.8*	C
			R	126	92.6	27.5	14.8	13.6	36.7	A
			L	84	89.6	26.2	14.7	14.1	34.6	A
		52	R	133	88.7	26.4	14.7	13.3	34.2	A
8	0-100-0	50	S	72	91.0	26.2	15.0	14.0	35.8	A
			R	54	88.0	26.9	12.4	13.2	35.4	A
		51	S	234	86.8	25.8*	14.6	13.3	33.2	C
			R	294	90.6	27.0	14.6	13.2	35.9	A
			L	192	86.9	25.8*	14.3	12.8	33.9	C
		52	R	66	85.1	24.5*	14.9	13.0	32.6*	C
9	40-60-0	50	S	72	92.7	27.0	14.9	14.2	36.5	A
			R	90	92.1	27.6	14.9	13.3	36.3	A
12	100 culls	50	S	36	89.3	28.0	15.0	13.5	32.8*	C
			R	18	86.0	25.7*	14.3	13.3	32.3*	C

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TABLE IV, cont'd

Lot No.	Raw Product Composition[x]	Year	Variety[#]	Can Count	Total Score	Color	Defects	Consistency	Flavor	Grade
13	75-0-25	51	R	72	92.8	28.4	14.8	12.7	36.8	A
		52	R	72	94.9	27.8	15.0	14.3	35.9	A
14	50-0-50	51	R	36	92.8	28.5	15.0	13.0	36.3	A
		52	R	84	92.7	27.5	15.0	14.0	36.2	A
15	25-75-0	51	S	54	88.2	26.1	14.6	13.3	34.2	A
			R	48	93.0	27.5	14.9	13.8	36.9	A
			L	69	85.9	24.7*	14.8	13.5	33.3	C
20	Field Run	51	S	36	92.5	27.3	14.5	14.3	36.3	A
			R	461	91.8	27.9	14.7	13.5	35.9	A
			L	53	85.7	24.6*	14.5	13.1	33.4	C
		52	R	144	89.5	26.6	14.8	13.4	34.7	A
30	90-10-0	49	S	54	89.6	26.6	14.9	13.9	34.6	A
			R	54	92.2	27.6	14.8	14.1	35.6	A
31	60-30-10	49	S	54	84.4	25.1*	14.9	12.5	31.4*	C
			R	42	79.2	27.4	14.7	11.8	31.2*	C

x - 1st No. indicates % No. 1's; 2nd No. % No. 2's account color; and 3rd No. % No. 2 account defects.

- S (Stokesdale); R (Rutgers); L (Long Red)

* - Indicates limiting rule within grade.

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TABLE V Grade Relationship of Canned Tomato Juice by Raw Product Grade, Year and Inspection# Disregarding Process and Variety.

Lot No.	Raw Product Composition[x]	Year	Total Score 1	Total Score 2	Total Score 3	Color 1	Color 2	Color 3	Defects 1	Defects 2	Defects 3	Consistency 1	Consistency 2	Consistency 3	Flavor 1	Flavor 2	Flavor 3	Grade 1	Grade 2	Grade 3
1	100-0-0	49	85.2	87.3	86.8	25.3*	26.0	26.1	14.9	14.9	14.5	12.6	13.0	13.3	32.7*	33.4	32.9*	C	A	C
		50	95.7	95.4	92.2	29.0	29.1	28.1	15.0	15.0	15.0	13.0	13.3	13.1	38.7	38.0	36.0	A	A	A
		51	91.8	92.1	90.1	27.7	27.7	27.3	14.6	14.9	14.4	14.0	13.9	13.2	35.6	35.7	34.9	A	A	A
		52	91.2	91.1	--	27.7	27.7	--	14.8	14.8	--	13.9	13.3	--	34.7	35.2	--	A	A	-
3	75-25-0	49	90.5	88.5	86.7	27.5	25.6*	25.5*	15.0	15.0	14.6	13.8	13.7	12.8	34.2	34.2	33.8	A	C	C
		50	95.1	94.8	93.5	28.3	28.5	28.4	15.0	14.8	14.8	14.4	13.8	13.9	37.6	37.8	36.4	A	A	A
		51	89.3	93.4	89.8	26.8	27.5	26.5	14.6	14.9	14.3	14.0	14.1	13.4	33.9	36.9	35.5	A	A	A
		52	90.6	93.6	—	27.4	27.6	--	15.0	15.0	—	15.0	14.2	--	33.2	36.8	—	A	A	-
4	75-15-10	49	92.1	89.6	89.3	27.7	26.7	27.0	14.9	14.9	14.7	13.8	14.2	13.4	35.8	33.8	34.2	A	A	A
		50	94.1	94.6	90.6	28.0	28.1	28.3	15.0	15.0	15.0	14.0	13.7	13.4	37.1	37.7	33.9	A	A	A
5	60-40-0	50	93.1	94.0	92.9	28.0	28.1	28.0	15.0	15.0	14.9	13.7	13.4	13.6	36.4	37.5	36.4	A	A	A
6	60-20-20	49	89.1	89.3	89.9	26.9	26.4	26.8	14.6	14.3	14.4	12.7	14.0	13.5	35.0	34.5	35.2	A	A	A
		50	94.1	93.2	90.6	28.6	28.3	28.1	14.8	15.0	15.0	14.0	13.4	13.0	36.7	36.4	34.5	A	A	A
7	50-50-0	50	92.3	92.9	92.8	27.5	28.2	28.0	15.0	15.0	15.0	13.6	13.3	13.3	36.3	36.3	36.4	A	A	A
		51	92.6	90.1	88.4	27.1	26.7	26.2	14.9	14.9	14.5	14.4	13.5	12.9	36.3	35.1	34.8	A	A	A
		52	88.2	89.2	—	26.5	26.3	—	14.6	14.8	—	13.4	13.3	—	33.6	34.8	—	A	A	-
8	0-100-0	50	88.2	92.3	88.7	25.7*	27.3	26.6	14.5	14.0	13.1	13.7	13.6	13.7	34.3	37.4	35.3	C	A	A
		51	90.2	87.9	87.2	26.8	26.0	26.0	14.5	14.7	14.3	13.8	13.3	12.4	35.0	33.8	34.5	A	A	A
		52	83.8	86.8	—	24.3*	24.8*	—	15.0	14.8	—	13.0	13.0	—	31.5	34.0	—	C	C	-
9	40-60-0	50	92.0	93.2	91.8	26.9	27.7	27.4	14.9	15.0	14.8	13.9	13.6	13.7	36.3	37.0	35.9	A	A	A
12	100 culls	50	88.5	85.0	84.0*	26.0	27.5	27.0	15.0	14.0	15.0	14.0	13.5	13.5	33.5	30.0*	28.0*	A	C	C
13	75-0-25	51	93.3	93.0	92.0	28.8	28.3	28.3	15.0	15.0	14.5	13.3	12.3	12.5	36.3	37.5	36.8	A	A	A
		52	92.0	93.8	—	27.8	27.8	—	15.0	15.0	--	14.5	14.0	—	34.7	37.2	—	A	A	-
14	50-0-50	51	94.5	90.5	93.5	28.5	28.0	29.0	15.0	15.0	15.0	14.0	12.0	13.0	37.0	35.5	36.5	A	A	A
		52	92.0	93.4	—	27.4	27.6	--	15.0	15.0	—	14.0	14.0	--	35.6	36.9	—	A	A	-

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TABLE V (cont'd)

Lot No.	Raw Product Composition[X]	Year	Total Score 1	Total Score 2	Total Score 3	Color 1	Color 2	Color 3	Defects 1	Defects 2	Defects 3	Consistency 1	Consistency 2	Consistency 3	Flavor 1	Flavor 2	Flavor 3	Grade 1	Grade 2	Grade 3
15	25-75-0	51	89.4	89.0	87.4	26.2	26.1	25.4*	14.6	14.9	14.7	13.8	14.0	12.7	34.8	34.3	34.7	A	A	C
20	Field Run	51	92.0	92.3	89.4	27.8	27.5	27.3	14.6	14.9	14.4	14.0	13.7	12.8	35.6	36.3	35.1	A	A	A
		52	89.1	89.9	—	26.6	26.6	—	14.6	14.9	—	13.7	13.2	—	34.3	35.2	—	A	A	—
30	90-10-0	49	91.7	91.6	89.4	27.8	26.8	26.7	15.0	14.9	14.6	14.0	14.6	13.5	34.9	35.7	34.6	A	A	A
31	60-30-10	49	76.0	88.0	89.3	26.0	26.0	26.4	14.8	14.9	14.7	10.1	13.3	13.2	25.1*	33.8	35.0	D	A	A

x - 1st No. indicates % No. 1's; 2nd No. % No. 2's account color; and 3rd No. % No. 2 account defects.

- Inspection (1 - two months; 2 - 6 months; 3 - 10 months)

* - Indicates limiting rule within grade.

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TABLE VI Grade Relationship of Canned Tomato Juice by Raw Product Grade and Process, Disregarding Year and Time of Inspection.

Lot No.	Raw Product Composition[x]	Process[#]	Can Count	Total Score	Color	Defects	Consistency	Flavor	Grade
1	100-0-0	1	323	91.9	28.0	14.7	13.6	35.6	A
		2	338	92.3	27.6	14.9	13.4	36.4	A
		5	72	87.2	26.1	14.5	13.2	33.3	A
		6	30	90.4	26.8	14.6	14.2	34.8	A
		7	104	89.9	28.1	14.1	13.8	33.6	A
		8	90	92.9	28.1	14.5	14.4	35.9	A
		9	104	89.4	26.6	14.6	13.8	34.4	A
3	75-25-0	1	144	93.5	27.9	14.7	14.5	36.4	A
		2	78	92.7	27.2	15.0	14.3	36.2	A
		5	30	76.0	23.2*	14.0	10.6	28.2*	C
		6	36	90.0	26.5	14.5	14.0	35.0	A
		9	18	92.3	27.3	14.7	14.7	35.7	A
7	50-50-0	1	181	89.9	26.9	14.7	13.4	35.0	A
		2	132	91.0	26.6	14.9	13.9	35.7	A
		5	48	85.4	25.1*	14.8	13.0	32.5*	C
		6	18	91.3	27.0	14.7	13.7	36.0	A
8	0-100-0	1	202	86.6	25.6*	14.5	12.6	33.9	C
		2	244	89.5	26.2	14.8	13.0	35.4	A
		5	36	82.9	23.9*	14.5	12.3	32.2*	C
		6	18	92.3	26.7	15.0	14.3	36.3	A
		7	54	85.4	26.3	13.9	13.9	31.3*	C
		8	89	91.5	26.8	14.7	14.5	35.5	A
		9	107	88.2	26.3	14.4	12.9	34.5	A
		0	36	86.2	28.0	14.0	13.7	30.5*	C
13	75-0-25	1	72	93.2	28.4	14.9	13.5	36.4	A
		2	72	92.5	27.8	14.9	13.4	36.3	A
14	50-0-50	1	54	93.4	27.8	15.0	13.9	36.8	A
		2	66	92.2	27.8	15.0	13.5	35.8	A
15	25-85-0	1	71	89.8	26.5	14.8	13.7	35.0	A
		2	29	86.2	24.5*	14.8	12.8	34.1	C
		5	35	87.4	25.7*	14.2	13.5	34.1	C
		6	18	91.0	27.0	15.0	14.0	35.0	A
		9	18	88.0	25.7*	15.0	13.3	34.0	C
20	Field Run	1	250	90.8	27.1	14.6	13.2	35.8	A
		2	126	91.2	27.2	14.7	13.7	35.9	A
		5	66	83.0	25.5*	14.4	12.4	30.7*	C
		6	36	93.2	27.3	14.7	14.3	36.8	A
		7	36	90.8	28.2	14.3	13.8	34.5	A
		8	54	94.2	27.9	14.9	14.4	37.0	A
		9	108	92.8	28.5	14.8	13.4	36.1	A
		0	18	94.0	28.0	15.0	14.3	36.7	A

\# – 1 Cold Break – 2 Extracts – Walker Wallace
2 Hot Break – Walker Wallace
5 Cold Break – 1 Extract-Mallory
6 Hot Break – Mallory
7 Cold Break – 2 Extracts – Conventional Cook
8 Hot Break – Conventional Cook
9 Cold Break – 1 Extract – Walker Wallace
0 Cold Break – 1 Extract – Conventional Cook

x – 1st No. indicates % No. 1's; 2nd No. % No. 2's account color; 3rd No. % No. 2 account defects.

* – Indicates limiting rule within grade.

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TABLE VII (cont'd)

Lot No.	Raw Product Composition[x]	Year	Process[#]	Can Count	Total Score	Color	Defects	Consis-tency	Flavor	Grade
20	Field Run	51	0	18	94.0	28.0	15.0	14.3	36.7	A
		51	1	142	91.6	27.3	14.6	13.2	36.5	A
		52	1	108	89.8	26.9	14.7	13.2	35.0	A
		51	2	90	92.3	27.8	14.7	13.5	36.7	A
		52	2	36	88.5	25.7*	14.8	14.2	33.8	C
		51	5	66	83.0	25.5*	14.4	12.4	30.7*	C
		51	6	36	93.2	27.3	14.7	14.3	36.8	A
		51	7	36	90.8	28.2	14.3	13.8	34.5	A
		51	8	54	94.2	27.9	14.9	14.4	37.0	A
		51	9	108	92.8	28.5	14.8	13.4	36.1	A

x - 1st No. indicates % No. 1's; 2nd No. % No. 2's account color; and 3rd No. % No. 2's account defects.

\# - 1 Cold Break - 2 Extracts - Walker Wallace
2 Hot Break - Walker Wallace
5 Cold Break - 1 Extract-Mallory
6 Hot Break - Mallory
7 Cold Break - 2 Extracts - Conventional Cook
8 Hot Break - Conventional Cook
9 Cold Break - 1 Extract - Walker Wallace
0 Cold Break - 1 Extract - Conventional Cook

* - Indicates limiting rule within grade.

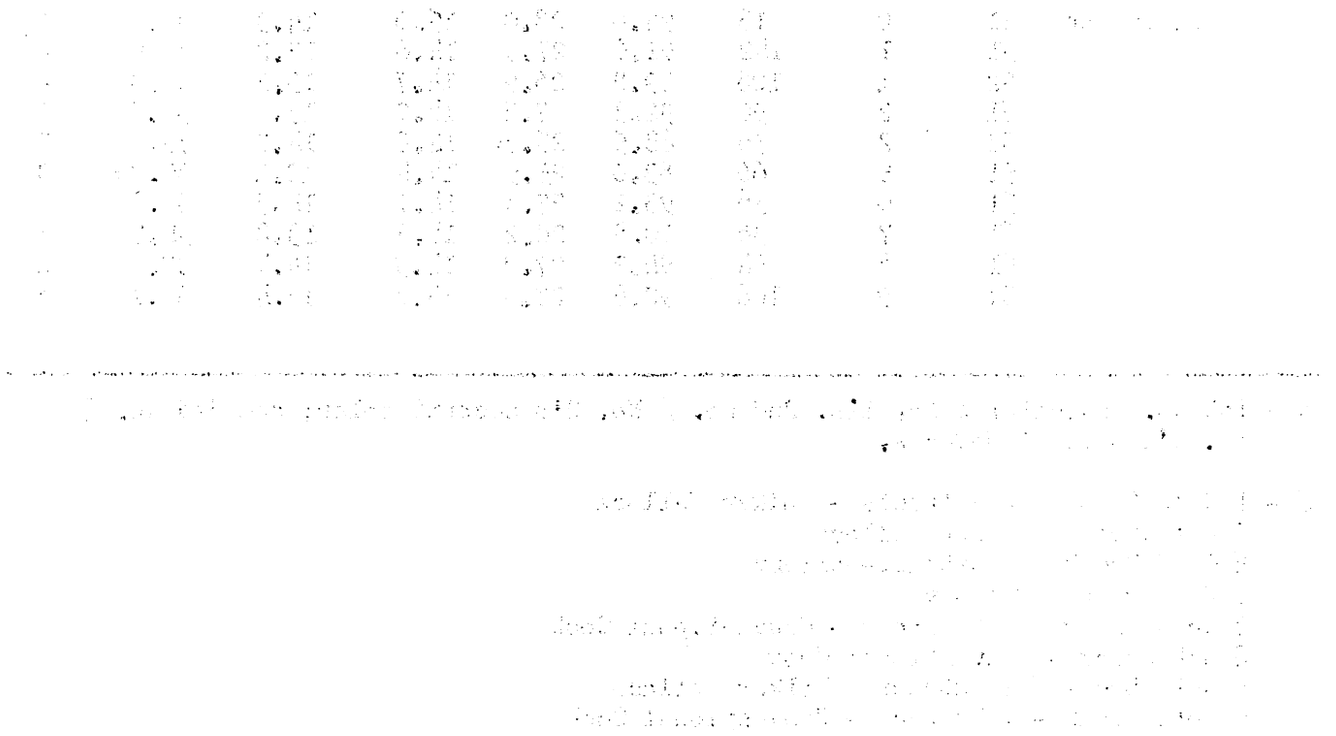

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TABLE VII Grade Relationship of Canned Tomato Juice by Raw Product Grade, Year (1951 and 1952 only) and Process, Disregarding Variety and Time of Inspection.

Lot No.	Raw Product Composition[X]	Year	Process[#]	Can Count	Total Score	Color	Defects	Consis-tency	Flavor	Grade
1	100-0-0	51	1	227	92.3	27.9	14.7	13.7	36.0	A
		52	1	96	91.1	28.1	14.8	13.5	34.6	A
		51	2	287	92.5	27.8	14.9	13.4	36.5	A
		52	2	51	91.3	26.9	14.9	13.8	35.6	A
		51	5	72	87.2	26.1	14.5	13.2	33.3	A
		51	6	30	90.4	26.8	14.6	14.2	34.8	A
		51	7	104	89.9	28.1	14.1	13.8	33.6	A
		51	8	90	92.9	28.1	14.5	14.4	35.9	A
		51	9	104	89.4	26.6	14.6	13.8	34.4	A
3	75-25-0	51	1	108	93.7	27.8	14.6	14.4	36.9	A
		52	1	36	92.7	28.2	15.0	14.7	34.8	A
		51	2	54	93.3	27.4	15.0	14.2	36.7	A
		52	2	24	91.3	26.5	15.0	14.5	35.3	A
		51	5	30	76.0	23.2*	14.0	10.6	28.2*	C
		51	6	36	90.0	26.5	14.5	14.0	35.0	A
		51	9	18	92.3	27.3	14.7	14.7	35.7	A
7	50-50-0	51	1	108	91.5	27.1	14.7	13.8	35.9	A
		52	1	73	87.6	26.7	14.6	12.8	33.5	A
		51	2	72	91.9	27.0	14.8	13.8	36.3	A
		52	2	60	90.0	26.1	14.9	14.0	35.0	A
		51	5	48	85.4	25.1*	14.8	13.0	32.5*	C
		51	6	18	91.3	27.0	14.7	13.7	36.0	A
8	0-100-0	51	1	172	87.2	25.9*	14.4	12.6	34.4	C
		52	1	30	83.0	24.2*	15.0	12.2	31.6*	C
		51	2	208	89.9	26.5	14.7	12.9	35.7	A
		52	2	36	86.8	24.8*	14.8	13.7	33.5	C
		51	5	36	82.9	23.9*	14.5	12.3	32.2*	C
		51	6	18	92.3	26.7	15.0	14.3	36.3	A
		51	7	54	85.4	26.3	13.9	13.9	31.3*	C
		51	8	89	91.5	26.8	14.7	14.5	35.5	A
		51	9	107	88.2	26.3	14.4	12.9	34.5	A
		51	0	36	86.2	28.0	14.0	13.7	30.5*	C
13	75-0-25	51	1	36	92.7	28.2	14.8	12.8	36.8	A
		52	1	36	93.7	28.7	15.0	14.2	36.0	A
		51	2	36	92.8	28.7	14.8	12.5	36.8	A
		52	2	36	92.2	27.0	15.0	14.3	35.8	A
14	50-0-50	51	1	18	95.0	28.3	15.0	14.0	37.7	A
		52	1	36	92.7	27.5	15.0	13.8	36.3	A
		51	2	18	90.7	28.7	15.0	12.0	35.0	A
		52	2	48	92.8	27.5	15.0	14.1	36.1	A
15	27-75-0	51	1	71	89.8	26.5	14.8	13.7	35.0	A
		51	2	29	86.1	24.5*	14.8	12.8	34.1	C
		51	5	35	87.4	25.7*	14.2	13.5	34.1	C
		51	6	18	91.0	27.0	15.0	14.0	35.0	A
		51	9	18	88.0	25.7*	15.0	13.3	34.0	C

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TABLE VIII Color Relationships between Hunter a/b Color Ratios of Raw Tomato Juice, Canned Tomato Juice and U.S.D.A. Color Scores Disregarding Variety, Year, Process and Time of Inspection.

RAW PRODUCT		CANNED PRODUCT			
a/b Color Ratio Group[o]	Average a/b Color Ratio	Average a/b Color Ratio	Average a/b Color Ratio Loss	Average U.S.D.A. Color Score	Color Grade
1.5	1.57	1.49	.08	22.3*	D
1.6	1.65	1.47	.18	24.6*	C
1.7	1.76	1.51	.25	24.3*	C
1.8	1.85	1.60	.25	26.2	A
1.9	1.95	1.57	.38	26.0	A
2.0	2.04	1.64	.40	26.8	A
2.1	2.15	1.74	.41	27.4	A
2.2	2.25	1.77	.48	27.7	A
2.3	2.34	1.84	.50	28.3	A
2.4	2.44	1.91	.53	28.5	A
2.5	2.55	1.95	.60	28.8	A
2.6	2.61	1.91	.70	28.9	A
2.7	2.71	1.86	.85	28.5	A

o - All lots grouped on a/b color ratio values. 1.5 group includes all lots 1.50 to 1.59, 1.6 group includes all lots 1.60 to 1.69, etc.

* - Indicates limiting rule within grade.

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TABLE IX Color Relationships between Hunter a/b Color Ratios of Raw Tomato Juice, Canned Tomato Juice and U.S.D.A. Color Scores by Variety, Disregarding Year, Process and Time of Inspection.

RAW PRODUCT			CANNED PRODUCT			
a/b Color Ratio Group°	Variety#	Average a/b Color Ratio	Average a/b Color Ratio	Average a/b Color Ratio Loss	Average U.S.D.A. Color Score	Color Grade
1.5	S	1.57	1.49	.08	22.3*	D
1.6	S	1.64	1.56	.08	25.8*	C
	R	1.67	1.41	.26	23.6*	C
	L	1.65	1.30	.35	22.7*	D
1.7	S	1.76	1.55	.21	24.0*	C
	R	1.74	1.42	.32	25.0*	C
1.8	S	1.84	1.69	.15	26.9	A
	R	1.84	1.53	.31	25.8*	C
	L	1.86	1.50	.36	25.4*	C
1.9	S	1.95	1.62	.33	26.1	A
	R	1.94	1.60	.34	26.7	A
	L	1.94	1.44	.50	24.8*	C
2.0	S	2.03	1.65	.38	26.8	A
	R	2.04	1.64	.40	26.9	A
	L	2.06	1.56	.50	26.0	A
2.1	S	2.16	1.77	.39	27.3	A
	R	2.15	1.74	.41	27.7	A
	L	2.15	1.68	.47	26.8	A
2.2	S	2.24	1.75	.49	27.3	A
	R	2.25	1.78	.47	27.9	A
	L	2.25	1.67	.58	26.6	A
2.3	S	2.34	1.94	.40	28.7	A
	R	2.33	1.82	.51	28.3	A
	L	2.35	1.86	.49	28.2	A
2.4	R	2.44	1.91	.53	28.5	A
2.5	R	2.55	1.95	.60	28.8	A
2.6	R	2.61	1.91	.70	28.9	A
2.7	R	2.71	1.86	.85	28.5	A

o - All lots grouped in a/b color ratio values. 1.5 group includes all lots 1.50 to 1.59, 1.6 group includes all lots 1.60 to 1.69, etc.
\# - S (Stokesdale); R (Rutgers); L (Long Red).
* - Indicates limiting rule within grade.

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TABLE X Color Relationships between Hunter a/b Ratios of Raw Tomato Juice, Canned Tomato Juice and U.S.D.A. Color Scores by Years, Disregarding Variety, Process and Time of Inspection.

RAW PRODUCT			CANNED PRODUCT			
a/b Color Ratio Group°	Year	Average a/b Color Ratio	Average a/b Color Ratio	Average a/b Color Ratio Loss	Average U.S.D.A. Color Score	Color Grade
1.5	51	1.57	1.49	.08	22.3*	D
1.6	50	1.62	1.54	.08	25.3*	C
	51	1.65	1.48	.17	24.9*	C
	52	1.67	1.41	.26	23.6*	C
1.7	50	1.76	1.79	+ .03	27.3	A
	51	1.77	1.19	.58	19.0*	D
	52	1.74	1.42	.32	25.0*	C
1.8	50	1.85	1.69	.16	26.8	A
	51	1.84	1.57	.27	25.8*	C
	52	1.86	1.45	.41	25.6*	C
1.9	50	1.97	1.75	.22	26.9	A
	51	1.94	1.56	.38	25.9*	C
	52	1.94	1.52	.42	26.4	A
2.0	50	2.03	1.73	.30	27.5	A
	51	2.04	1.63	.41	36.7	A
	52	2.06	1.56	.50	26.3	A
2.1	50	2.15	1.81	.34	27.5	A
	51	2.15	1.73	.42	27.5	A
	52	2.14	1.57	.57	26.8	A
2.2	50	2.27	1.84	.43	28.1	A
	51	2.24	1.75	.49	27.7	A
	52	2.25	1.73	.52	27.6	A
2.3	50	2.33	1.95	.38	28.7	A
	51	2.34	1.84	.50	28.3	A
	52	2.34	1.74	.60	27.9	A
2.4	50	2.44	1.93	.51	28.6	A
	51	2.44	1.87	.57	28.3	A
	52	2.43	1.93	.50	29.2	A
2.5	50	2.55	2.00	.55	28.9	A
	51	2.56	1.75	.81	28.0	A
	52	2.56	1.92	.64	28.6	A
2.6	51	2.61	1.87	.74	28.7	A
	52	2.61	2.01	.60	29.5	A
2.7	52	2.71	1.86	.85	28.5	A

o - All lots grouped in a/b color ratio values. 1.5 group includes all lots 1.50 to 1.59, 1.6 group includes all lots 1.60 to 1.69, etc.

* - Indicates limiting rule within grade.

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TABLE XI Color Relationships between Hunter a/b Color Ratios of Raw Tomato Juice, Canned Tomato Juice and U.S.D.A. Color Scores by Year and Variety, Disregarding Process and Time of Inspection.

RAW PRODUCT				CANNED PRODUCT			
a/b Color Ratio Group°	Year	Variety#	Average a/b Color Ratio	Average a/b Color Ratio	Average a/b Color Ratio Loss	Av. U.S.D.A. Color Score	Color Grade
1.5	51	S	1.57	1.49	.08	22.3*	D
1.6	50	S	1.62	1.54	.08	25.3*	C
	51	S	1.65	1.57	.08	26.0	A
		L	1.65	1.30	.35	22.7*	D
	52	R	1.67	1.41	.26	23.6*	C
1.7	50	S	1.76	1.79	+ .03	27.3	A
	51	S	1.77	1.19	.58	19.0*	D
	52	R	1.74	1.42	.32	25.0*	C
1.8	50	S	1.85	1.71	.14	27.0	A
		R	1.83	1.51	.32	25.7*	C
	51	S	1.82	1.65	.17	26.6	A
	R	R	1.81	1.61	.20	25.9*	C
		L	1.86	1.50	.36	25.4*	C
	52	R	1.86	1.45	.41	25.6*	C
1.9	50	S	1.97	1.74	.23	26.9	A
	51	S	1.94	1.59	.35	26.0	A
		R	1.94	1.62	.32	26.8	A
		L	1.94	1.44	.50	24.8*	C
	52	R	1.94	1.52	.42	26.4	A
2.0	50	S	2.04	1.74	.30	27.6	A
		R	2.02	1.69	.33	26.7	A
	51	S	2.03	1.53	.50	25.7*	C
		R	2.03	1.68	.35	27.3	A
		L	2.06	1.56	.50	26.0	A
	52	R	2.06	1.56	.50	26.3	A
2.1	50	S	2.15	1.84	.31	27.7	A
		R	2.15	1.79	.36	27.3	A
	51	S	2.17	1.63	.54	26.5	A
		R	2.15	1.79	.36	28.3	A
		L	2.15	1.68	.47	26.8	A
	52	R	2.14	1.57	.57	26.8	A
2.2	50	S	2.26	1.77	.49	27.5	A
		R	2.28	1.90	.38	28.5	A
	51	S	2.23	1.73	.50	27.2	A
		R	2.24	1.77	.47	27.9	A
		L	2.25	1.67	.58	26.6	A
	52	R	2.25	1.73	.52	27.6	A
2.3	50	S	2.34	1.94	.40	28.7	A
		R	2.30	1.97	.33	28.7	A
	51	R	2.33	1.83	.50	28.4	A
		L	2.35	1.86	.49	28.2	A
	52	R	2.34	1.74	.60	27.9	A

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TABLE XI (cont'd)

a/b Color Ratio Group°	Year	Variety#	RAW PRODUCT Average a/b Color Ratio	CANNED PRODUCT Average a/b Color Ratio	Average a/b Color Ratio Loss	Av. U.S.D.A. Color Score	Color Grade
2.4	50	R	2.44	1.93	.51	28.6	A
	51	R	2.44	1.87	.57	28.3	A
	52	R	2.43	1.93	.50	29.2	A
2.5	50	R	2.55	2.00	.55	28.9	A
	51	R	2.56	1.75	.81	28.0	A
	52	R	2.56	1.92	.64	28.6	A
2.6	51	R	2.61	1.87	.74	28.7	A
	52	R	2.61	2.01	.60	29.5	A
2.7	52	R	2.71	1.86	.85	28.5	A

o - All lots grouped in a/b color ratio values. 1.5 group includes all lots 1.50 to 1.59, 1.6 group includes all lots 1.60 to 1.69, etc.

- S (Stokesdale); R (Rutgers); L (Long Red).

* - Indicates limiting rule within grade.

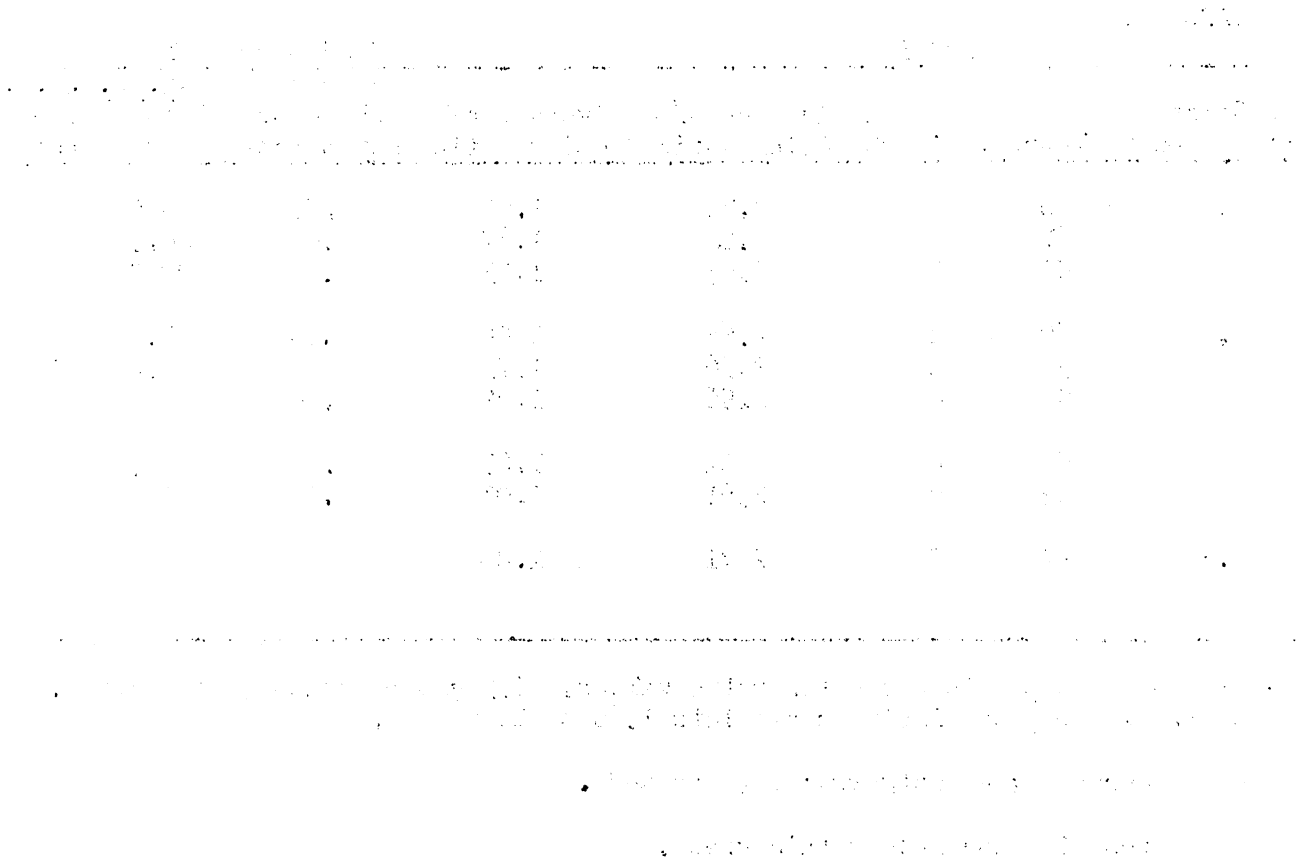

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TABLE XII Color Relationship between Hunter a/b Color Ratios of Raw Tomato Juice, Canned Tomato Juice and U.S.D.A. Color Scores and Grades by Year and Time of Inspection, Disregarding Variety and Process.

		RAW PRODUCT		CANNED PRODUCT			
a/b Color Ratio Group°	Year	Inspection#	Average a/b Color Ratio	Average a/b Color Ratio	Average a/b Color Ratio Loss	Av. U.D.S.A. Color Score	Color Grade
1.5	51	1	1.57	1.31	.26	22.0*	D
		2	1.57	1.24	.33	23.0*	C
		3	1.57	1.27	.30	22.0*	D
1.6	50	1	1.62	1.45	.17	25.0*	C
		2	1.62	1.37	.25	27.0	A
		3	1.62	1.81	+ .19	24.0*	C
	51	1	1.65	1.48	.17	25.0*	C
		2	1.65	1.44	.21	25.3*	C
		3	1.65	1.52	.13	24.3*	C
	52	1	1.66	1.44	.22	23.3*	C
		2	1.69	1.36	.33	24.0*	C
1.7	50	1	1.76	1.74	.02	27.0	A
		2	1.76	1.61	.15	27.0	A
		3	1.76	2.02	+ .26	28.0	A
	51	1	1.77	1.14	.63	15.0*	D
		3	1.77	1.23	.54	23.0*	C
	52	1	1.74	1.40	.34	25.0*	C
		2	1.74	1.44	.30	25.0*	C
1.8	50	1	1.85	1.65	.20	26.2	A
		2	1.85	1.53	.32	27.6	A
		3	1.85	1.88	+ .03	26.8	A
	51	1	1.84	1.56	.28	26.5	A
		2	1.84	1.48	.36	25.7*	C
		3	1.84	1.66	.18	25.2*	C
	52	1	1.86	1.44	.42	25.8*	C
		2	1.86	1.47	.39	25.5*	C
1.9	50	1	1.97	1.68	.29	27.0	A
		2	1.97	1.63	.34	27.0	A
		3	1.97	1.92	.05	26.7	A
	51	1	1.94	1.58	.36	26.4	A
		2	1.94	1.52	.42	25.8*	C
		3	1.94	1.58	.36	25.5*	C
	52	1	1.94	1.57	.37	26.3	A
		2	1.94	1.49	.45	26.5	A
2.0	50	1	2.03	1.67	.36	27.0	A
		2	2.03	1.63	.40	28.0	A
		3	2.03	1.89	.14	27.4	A
	51	1	2.04	1.65	.39	27.4	A
		2	2.04	1.57	.47	26.8	A
		3	2.04	1.68	.36	26.1	A
	52	1	2.06	1.58	.48	26.4	A
		2	2.06	1.55	.51	26.3	A

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TABLE XII (cont'd)

RAW PRODUCT				CANNED PRODUCT			
a/b Color Ratio Group°	Year	Inspection#	Average a/b Color Ratio	Average a/b Color Ratio	Average a/b Color Ratio Loss	Av. Color Score	U.S.D.A. Color Grade
2.1	50	1	2.15	1.79	.36	27.2	A
		2	2.15	1.69	.46	27.9	A
		3	2.15	1.96	.19	27.4	A
	51	1	2.15	1.75	.40	27.7	A
		2	2.15	1.67	.48	27.4	A
		3	2.15	1.76	.39	27.3	A
	52	1	2.14	1.59	.55	26.9	A
		2	2.14	1.56	.58	26.7	A
2.2	50	1	2.27	1.82	.45	27.8	A
		2	2.27	1.73	.54	28.3	A
		3	2.27	1.97	.30	28.1	A
	51	1	2.24	1.76	.48	27.8	A
		2	2.24	1.72	.52	27.6	A
		3	2.24	1.78	.46	27.6	A
	52	1	2.25	1.72	.53	27.6	A
		2	2.25	1.74	.51	27.6	A
2.3	50	1	2.33	1.90	.43	29.0	A
		2	2.33	1.85	.48	28.3	A
		3	2.33	2.09	.24	28.7	A
	51	1	2.34	1.84	.50	28.3	A
		2	2.34	1.80	.54	28.4	A
		3	2.34	1.88	.46	28.3	A
	52	1	2.34	1.73	.61	27.6	A
		2	2.34	1.76	.58	28.1	A
2.4	50	1	2.44	1.92	.52	28.6	A
		2	2.44	1.82	.62	28.5	A
		3	2.44	2.04	.40	28.5	A
	51	1	2.44	1.87	.57	28.5	A
		2	2.44	1.84	.60	28.0	A
		3	2.44	1.91	.53	28.3	A
	52	1	2.43	1.91	.52	29.0	A
		2	2.43	1.95	.48	29.3	A
2.5	50	1	2.55	2.00	.55	28.7	A
		2	2.55	1.91	.64	29.3	A
		3	2.55	2.09	.46	28.8	A
	51	1	2.56	1.78	.78	28.0	A
		2	2.56	1.64	.92	29.0	A
		3	2.56	1.83	.73	27.0	A
	52	1	2.56	1.92	.64	28.8	A
		2	2.56	1.93	.63	28.5	A
2.6	51	1	2.61	1.86	.75	28.5	A
		2	2.61	1.85	.76	29.0	A
		3	2.61	1.91	.70	28.5	A
	52	1	2.61	1.96	.65	30.0	A
		2	2.61	2.05	.56	29.0	A
2.7	52	1	2.71	1.92	.79	28.0	A
		2	2.71	1.79	.92	29.0	A

o - All lots grouped in a/b color ratio values. 1.5 group includes all lots 1.50 to 1.59, 1.6 group includes all lots 1.60 to 1.69, etc.
- Inspection (1 - After two months storage; 2 - After 6 months; 3 - After 10 months)
* - Indicates limiting fule within grade.

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TABLE XIII Color Relationship between Hunter a/b Color Ratios of Raw Tomato Juice, Canned Tomato Juice and U.S.D.A. Color Score by Process, Disregarding Variety, Year and Time of Inspection.

	RAW PRODUCT		CANNED PRODUCT			
a/b Color Ratio Group°	Process#	Average a/b Color Ratio	Average a/b Color Ratio	Average a/b Color Ratio Loss	Av. U.S.D.A. Color Score	Color Grade
1.5	9	1.57	1.49	.08	22.3*	D
1.6	1	1.64	1.28	.36	22.3*	D
	2	1.69	1.45	.24	24.3*	C
	7	1.68	1.60	.08	25.0*	C
	9	1.65	1.57	.08	26.1	A
1.7	1	1.74	1.42	.32	25.0*	C
	5	1.77	1.19	.58	19.0*	D
1.8	0	1.83	1.73	.10	28.3	A
	1	1.83	1.48	.35	25.3*	C
	2	1.86	1.60	.26	26.3	A
	5	1.85	1.49	.36	25.1*	C
	9	1.83	1.76	.07	27.0	A
1.9	1	1.93	1.55	.38	25.9*	C
	2	1.93	1.58	.35	25.6*	C
	5	1.97	1.49	.48	25.6*	C
	6	1.96	1.62	.34	26.7	A
	7	1.95	1.55	.40	25.8*	C
	8	1.91	1.61	.30	25.8*	C
	9	1.97	1.58	.39	26.6	A
2.0	1	2.05	1.65	.40	27.0	A
	2	2.05	1.64	.41	26.7	A
	5	2.03	1.50	.53	25.5*	C
	6	2.03	1.64	.39	26.9	A
	7	2.03	1.69	.34	28.0	A
	8	2.00	1.61	.39	27.3	A
	9	2.02	1.59	.43	26.6	A
2.1	0	2.14	1.71	.43	27.8	A
	1	2.15	1.70	.45	27.6	A
	2	2.15	1.64	.51	26.6	A
	6	2.18	1.70	.48	27.1	A
	8	2.15	1.74	.41	27.8	A
	9	2.15	1.78	.37	27.8	A
2.2	1	2.25	1.75	.50	27.7	A
	2	2.24	1.76	.48	27.4	A
	7	2.25	1.69	.56	27.5	A
	8	2.24	1.74	.50	27.8	A
	9	2.25	1.78	.47	28.6	A
2.3	1	2.34	1.85	.49	28.6	A
	2	2.34	1.78	.56	27.8	A
	7	2.35	1.87	.48	29.0	A
	8	2.31	1.80	.51	27.8	A

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TABLE XIII (cont'd)

RAW PRODUCT			CANNED PRODUCT			
a/b Color Ratio Group[o]	Process[#]	Average a/b Color Ratio	Average a/b Color Ratio	Average a/b Color Ratio Loss	Av. U.S.D.A. Color Score	Color Grade
2.4	1	2.43	1.85	.58	28.5	A
	2	2.44	1.91	.53	28.4	A
	8	2.45	1.90	.55	28.3	A
2.5	1	2.57	1.97	.80	29.0	A
	2	2.54	1.77	.77	27.8	A
2.6	1	2.61	2.01	.60	29.5	A
	2	2.61	1.85	.76	28.7	A
	8	2.61	1.89	.72	28.7	A
2.7	2	2.71	1.86	.85	28.5	A

o - All lots grouped in a/b color ratio values. 1.5 group includes all lots 1.50 to 1.59, 1.6 group includes all lots 1.60 to 1.69, etc.

- 1 Cold Break - 2 Extracts - Walker Wallace
2 Hot Break - Walker Wallace
5 Cold Break - 1 Extract-Mallory
6 Hot Break - Mallory
7 Cold Break - 2 Extracts - Conventional Cook
8 Hot Break - Conventional Cook
9 Cold Break - 1 Extract - Walker Wallace
0 Cold Break - 1 Extract - Conventional Cook

* - Indicates limiting rule within grade.

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TABLE XIV Color Relationship between Hunter a/b Color Ratios of Raw Tomato Juice, Canned Tomato Juice and U.S.D.A. Color Scores by Process, Year and Variety Disregarding Time of Inspection.

RAW PRODUCT					CANNED PRODUCT			
a/b Color Ratio Group[o]	Process[#]	Variety[x]	Year	Average a/b Color Ratio	Average a/b Color Ratio	Average a/b Color Ratio Loss	Color Score	Color Grade
1.5	9	S	51	1.57	1.49	.08	22.3*	D
1.6	1	S	50	1.62	1.54	.08	25.3*	C
		R	52	1.61	1.24	.37	21.0*	D
		L	51	1.65	1.30	.35	22.7*	D
	2	R	52	1.69	1.45	.24	24.2*	C
	9	S	51	1.65	1.57	.08	26.1	A
1.7	1	S	50	1.76	1.79	+ .03	27.3	A
		R	52	1.74	1.42	.32	25.0*	C
	5	S	51	1.77	1.18	.59	19.0*	D
1.8	0	S	51	1.83	1.73	.10	28.3	A
	1	S	50	1.86	1.71	.15	27.1	A
		R	50	1.83	1.51	.32	25.7*	C
			51	1.81	1.62	.19	25.5*	C
			52	1.85	1.33	.52	25.5*	C
		L	51	1.85	1.46	.39	24.8*	C
	2	S	50	1.81	1.72	.09	25.9*	C
		R	51	1.82	1.60	.22	26.7	A
			52	1.88	1.58	.30	25.8*	C
		L	51	1.86	1.62	.24	26.7	A
	5	S	51	1.80	1.47	.33	24.3*	C
		L	51	1.87	1.49	.38	25.3*	C
	9	S	51	1.83	1.76	.07	27.0	A
1.9	1	S	50	1.97	1.75	.22	26.9	A
			51	1.92	1.65	.27	25.7*	C
		R	51	1.94	1.68	.26	27.2	A
			52	1.94	1.53	.41	26.6	A
		L	51	1.92	1.40	.52	24.9*	C
	2	S	51	1.91	1.68	.23	26.2	A
		R	51	1.92	1.66	.26	27.0	A
		L	51	1.95	1.45	.50	24.2*	C
	5	S	51	1.99	1.45	.54	25.4*	C
		R	51	1.92	1.57	.35	26.0	A
		L	51	1.97	1.48	.49	25.7*	C
	6	S	51	1.99	1.64	.35	27.0	A
		R	51	1.92	1.59	.33	26.3	A
	7	S	51	1.95	1.55	.40	25.8*	C
	8	S	51	1.91	1.61	.30	25.8*	C
	9	S	51	1.96	1.58	.38	26.4	A
		R	51	1.98	1.58	.40	26.9	A
2.0	1	S	50	2.04	1.74	.30	27.6	A
		R	50	2.02	1.69	.33	26.7	A
			51	2.05	1.73	.32	27.4	A
			52	2.06	1.59	.45	26.6	A
		L	51	2.06	1.56	.50	26.4	A

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TABLE XIV (cont'd)

a/b Color Ratio Group°	Process#	Variety×	Year	RAW PRODUCT Average a/b Color Ratio	CANNED PRODUCT Average a/b Color Ratio	Average a/b Color Ratio Loss	Color Score	Color Grade
2.0 (cont'd)	2	R	51	2.04	1.76	.28	27.7	A
			52	2.06	1.51	.55	25.8*	C
		L	51	2.07	1.56	.51	25.7*	C
	5	S	51	2.04	1.42	.62	24.5*	C
		R	51	2.02	1.54	.48	26.2	A
		L	51	2.07	1.58	.49	25.3*	C
	6	S	51	2.02	1.66	.36	26.9	A
		R	51	2.05	1.60	.45	27.0	A
	7	R	51	2.03	1.69	.34	28.0	A
	8	R	51	2.00	1.61	.39	27.3	A
	9	S	51	2.03	1.51	.52	25.9*	C
		R	51	2.00	1.74	.26	28.1	A
2.1	0	R	50	2.15	1.75	.40	28.0	A
		L	51	2.12	1.67	.35	27.7	A
	1	S	50	2.15	1.84	.31	27.7	A
		R	50	2.15	1.79	.36	27.3	A
			51	2.15	1.73	.42	28.0	A
			52	2.13	1.66	.47	27.3	A
		L	51	2.15	1.67	.48	27.1	A
	2	S	51	2.17	1.65	.52	26.3	A
		R	51	2.15	1.88	.27	28.0	A
			52	2.14	1.52	.62	26.5	A
		L	51	2.16	1.67	.49	26.0	A
	6	S	51	2.18	1.70	.48	27.1	A
	8	R	51	2.16	1.79	.37	29.0	A
		L	51	2.14	1.68	.46	26.7	A
	9	S	51	2.17	1.41	.76	25.3*	C
		R	51	2.15	1.86	.29	28.7	A
		L	51	2.14	1.80	.34	26.7	A
2.2	1	S	50	2.26	1.77	.49	27.5	A
			51	2.20	1.73	.47	27.0	A
		R	50	2.28	1.90	.38	28.5	A
			51	2.25	1.77	.48	27.8	A
			52	2.25	1.75	.50	28.0	A
		L	51	2.26	1.55	.71	26.3	A
	2	S	51	2.25	1.80	.45	26.4	A
		R	51	2.23	1.80	.43	27.9	A
			52	2.25	1.71	.54	27.2	A
		L	51	2.24	1.72	.52	26.7	A
	7	S	51	2.23	1.69	.54	27.2	A
		R	51	2.26	1.70	.56	27.6	A
	8	S	51	2.25	1.78	.47	28.0	A
		R	51	2.23	1.73	.50	27.7	A
	9	R	51	2.25	1.78	.47	28.5	A
2.3	1	S	50	2.34	1.94	.40	28.7	A
		R	50	2.30	1.97	.33	28.7	A
			51	2.33	1.86	.47	28.6	A
			52	2.33	1.74	.59	28.4	A
		L	51	2.37	2.02	.35	28.7	A

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TABLE XIV (cont'd)

RAW PRODUCT					CANNED PRODUCT			
a/b Color Ratio Group°	Process#	Variety#	Year	Average a/b Color Ratio	Average a/b Color Ratio	Average a/b Color Ratio Loss	Color Score	Color Grade
2.3 (cont'd)	2	R	51	2.34	1.81	.53	28.1	A
			52	2.35	1.74	.61	27.2	A
		L	51	2.33	1.76	.57	27.6	A
	7	R	51	2.34	1.82	.52	28.7	A
		L	51	2.37	2.00	.37	29.7	A
	8	R	51	2.31	1.80	.51	28.0	A
2.4	1	R	50	2.44	1.92	.52	28.6	A
			51	2.43	1.77	.66	27.9	A
			52	2.43	1.93	.50	29.2	A
	2	R	51	2.44	1.91	.53	28.4	A
	8	R	51	2.45	1.90	.55	28.3	A
2.5	1	R	50	2.55	2.00	.55	29.0	A
			52	2.57	1.97	.60	29.0	A
	2	R	51	2.56	1.75	.81	28.0	A
			52	2.51	1.79	.72	27.5	A
2.6	1	R	52	2.61	2.01	.60	29.5	A
	2	R	51	2.61	1.85	.76	28.7	A
	8	R	51	2.61	1.89	.72	28.7	A
2.7	2	R	52	2.71	1.85	.86	28.5	A

o - All lots grouped in a/b color ratio values. 1.5 group includes all lots 1.50 to 1.59, 1.6 group includes all lots 1.60 to 1.69, etc.

- 1 Cold Break - 2 Extracts - Walker Wallace
2 Hot Break - Walker Wallace
5 Cold Break - 1 Extract-Mallory
6 Hot Break - Mallory
7 Cold Break - 1 Extract-Mallory
8 Hot Break - Conventional Cook
9 Cold Break - 1 Extract - Walker Wallace
0 Cold Break - 1 Extract - Conventional Cook

x - S (Stokesdale); R (Rutgers); L (Long Red)

* - Indicates limiting rule within grade.

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TABLE XV. Yield Relationship by Raw Product Composition, Process, Year and Variety in Percent Yield of Raw Juice prior to Processing for 1951 and 1952.

Lot No.	Raw Product Composition[x]	Process[#]	Variety*	Average Percent Yield of Raw Juice
1	100-0-0	1	S	72.0
			R	79.9
			L	76.7
		2	S	70.5
			R	80.0
			L	81.3
		5	S	71.0
			R	59.0
			L	61.0
		6	S	77.5
		7	S	72.0
			R	85.0
			L	75.0
		8	R	82.0
		9	S	65.3
			R	66.5
3	75-25-0	1	R	78.0
			L	78.0
		2	R	76.8
			L	83.0
		5	S	76.0
			R	59.0
		6	S	85.0
			R	70.0
		9	S	72.0
7	50-50-0	1	R	78.1
			L	77.0
		2	R	81.6
			L	83.0
		5	S	76.0
			L	73.0
		6	S	84.0
8	0-100-0	0	S	61.0
			L	62.0
		1	S	71.5
			R	81.0
			L	76.0
		2	S	75.0
			R	77.7
			L	79.0
		5	S	78.0
			L	76.0
		6	S	78.0
		7	S	71.5
			R	80.0
		8	S	75.0
			R	77.0
		9	S	56.0
			R	62.0

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TABLE XV (cont'd)

Lot No.	Raw Product Composition[x]	Process[#]	Variety[*]	Average Percent Yield of Raw Juice
13	75-0-25	1	R	79.0
		2	R	78.8
14	50-50-0	1	R	82.3
		2	R	77.2
15	25-75-0	1	R	75.5
			L	75.0
		2	R	82.0
		5	S	77.0
		6	S	83.0
		9	S	74.0
20	Field Run	0	R	59.0
		1	R	75.4
			L	84.0
		2	R	81.0
		5	R	60.0
			L	78.0
		6	S	68.0
			R	78.0
		7	R	78.5
		8	R	81.0
		9	S	68.0
			R	61.6

x - 1st number indicates % No. 1's; 2nd No. % No. 2's account color; and 3rd No. % No. 2's account defects.

- 1 Cold Break - 2 Extracts - Walker Wallace
2 Hot Break - Walker Wallace
5 Cold Break - 1 Extract-Mallory
6 Hot Break - Mallory
7 Cold Break - 2 Extracts - Conventional Cook
8 Hot Break - Conventional Cook
9 Cold Break - 1 Extract - Walker Wallace
0 Cold Break - 1 Extract - Conventional Cook

* - S (Stokesdale); R (Rutgers); L (Long Red).

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